KNOWLEDGE
AN ILLUSTRATED
MAGAZINE OF SCIENCE
SIMPLY WORDED—EXACTLY DESCRIBED

LONDON: SEPTEMBER 1, 1894.

CONTENTS.

	PAGE
The Ancient Mammals of Britain.—II. By R. LYDEKKER, B.A.Cantab., F.R.S.	193
Insect Secretions.—V. By E. A. BUTLER, B.A., B.Sc. ...	196
The Wanderings of a Sunspot. By E. WALTER MAUNDER	198
On the Origin of the Gold in Quartz Veins. By HENRY LOUIS, Assoc. R.S.M., &c.	201
What is a Star Cluster? By A. C. RANYARD	204
Notices of Books...	206
Letters :—A. M. CLERKE; GEO. H. PETHYBRIDGE; W. T. LYNN	206
Antarctic Birds. By WILLIAM S. BRUCE	208
Types of Floral Structure.—II. By the Rev. A. S. WILSON, M.A., B.Sc.	210
The Water-Hen. By HARRY F. WITHERBY	212
The Face of the Sky for September. By HERBERT SADLER, F.R.A.S.	214
Chess Column. By C. D. LOCOCK, B.A.Oxon.	215

THE ANCIENT MAMMALS OF BRITAIN.

II.—THE FOREST-BED AND CRAG PERIODS.

By R. LYDEKKER, B.A.Cantab., F.R.S.

THE freshwater deposit on the eastern coast of England known as the forest-bed, of which the age is preglacial, occupies a somewhat intermediate position in regard to its mammalian fauna between the cavern and crag periods; some of the species characterizing the former epoch extending downwards to the forest-bed, while others are replaced by those of the crag. Still, however, the percentage of existing species is high, and as but few of the genera appear to be extinct, we prefer to assign the formation in question to the Pleistocene rather than to the Pliocene epoch.

Commencing with the carnivores, we have evidence that the forest-bed possesses a sabre-toothed tiger apparently specifically distinct from the cavern species, and not improbably identical with one (*Machærodus cultridrens*) from the upper Pliocene beds of the Val d'Arno in Tuscany; while the hyæna is identical with the cavern form, that is to say, the existing South African species. The wolf, and probably the fox, as well as the marten and the glutton, are likewise existing species ranging as far down as the forest-bed; and the occurrence of the last-named is somewhat notable, as showing that even at this early epoch northern types were capable of existing in England before we have any evidence of the incoming of strongly-marked glacial conditions. The other land carnivores of the forest-bed are the otter and the cave-bear; while the teeth of a smaller bear have been tentatively assigned to the American grizzly, although we should think it more probable that they pertained to the brown species. Of marine forms, a walrus which has been regarded as specifically distinct from the living representative of the genus, and the bearded seal (*Phoca barbata*), now inhabiting the North Atlantic, have been recorded from the formation under consideration.

In the hoofed order we find the bison and the musk-ox, as well as a large sheep (*Ovis savini*) apparently allied to the Himalayan argali, inhabiting East Anglia during the deposition of the forest-bed; while the roebuck, an extinct kind of elk (*Alces latifrons*), and the red deer likewise lived at the same time. There appear also to have been several species of extinct deer, among which Savin's deer (*Cervus savini*) is remarkable for the flattened form of the brow-tine, while in the magnificent species (*C. sedgwicki*) named after the well-known professor of geology at Cambridge the spreading antlers attained a complexity of structure unknown in any other member of the genus. Of other ungulates, the hippopotamus, the wild boar, and the horse date from the forest-bed; and the occurrence in this formation of the former species in association with the musk-ox, glutton, and walrus, presents us with another of the puzzles which almost break the heart of the palæontologist. In addition to the common horse, there was an extinct species known as Steno's horse (*Equus stenonis*) and distinguished by the small size of the so-called front inner pillar of the upper molar teeth, or the portion occupying the middle of the lower border of the annexed figure. In this respect the species in question was less specialized than the modern horse, and makes a step in the direction of the under-mentioned hipparion. On the Continent Steno's horse occurs in beds of upper Pliocene age, where it was accompanied by the Etruscan rhinoceros (*Rhinoceros etuscus*), as was also the case in the forest-bed. This Etruscan rhinoceros differs from the leptorhine and megarhine cavern species by the much lower crowns of its molar teeth, and is likewise, therefore, a more generalized type. So far as can be determined, the mammoth does not appear to have come into existence at the period of the forest-bed; but the so-called straight-tusked elephant (*Elephas antiquus*) was abundant, as well as a third species (*E. meridionalis*), unknown in the higher deposits. This southern elephant, which takes its name from its occurrence in the upper Pliocene strata of the Val d'Arno, attained enormous dimensions, and is characterized by the smallness of the height of the crowns of the molar teeth in comparison with their width, as well as by the large size and lozenge-like form of the discs of ivory enclosed by the enamel-plates on their grinding surface, and the width of the intervening spaces of cement. The enamel-plates themselves are very thick and smooth, being almost completely devoid of the puckerings characterizing those of the mammoth. Although anyone can see the difference between a typical molar of the southern elephant and one of the mammoth, some teeth of the former are very like certain of those of the straight-toothed elephant, while some of the latter come very close to those of the mammoth. It is, therefore, advisable in determining the teeth of fossil elephants to seek the aid of a specialist. It may

FIG. 1.—Right upper molar tooth of Steno's Horse.

be added that remains of the southern elephant have been met with in a remarkable deposit at Dewlish, in Dorsetshire, which must consequently be correlated either with the forest-bed or the upper crags.

Among the smaller mammals we find the rodents well represented in the forest-bed, some of the species still existing in Britain, while others are now confined to the Continent, and a few are extinct. In the former class we have the squirrel, the wood-mouse (*Mus sylvaticus*), and the bank-vole (*Microtus glareolus*); and in the second the beaver, the continental field-vole (*M. arvalis*), and the Siberian vole (*M. gregalis*); while of the extinct forms the giant beaver (*Trogontherium cuvieri*) indicates a genus characteristic of this formation and the upper Pliocene, and a vole (*M. intermedius*) intermediate in size between the water-vole and field-vole differs from both in having distinct roots to the molar teeth. In the insectivorous order we have the mole, and the common and pigmy shrews, as representatives of the existing British fauna; while the Russian desman (*Myogale moschata*) is now found only in the districts between the rivers Don and Volga, where it leads an aquatic life, not unlike that of our water-vole, save that its habits are insectivorous instead of herbivorous.

The few cetacean remains from the forest-bed appear all referable to existing forms, and indicate the same mixture of southern and northern forms as characterizes the land fauna. Among these are the southern right whale (*Balæna australis*), a large fin-whale (*Balænoptera*), the sperm-whale—which still occasionally straggles as far north as Britain—the killer, or grampus (*Orca gladiator*), the false killer (*Pseudorca crassidens*)—originally described from a skull from the fens near Stamford, but subsequently found living in the North Sea,—the Arctic narwhal (*Monodon monoceros*), and white whale (*Delphinapterus leucas*), the common dolphin, the bottle-nosed dolphin, and the porpoise.

We now come to the shelly deposits of the east coast, locally known by the term of "crags," a name which has been adopted into geological nomenclature. These beds admit of a three-fold division, namely the Norwich, fluvio-marine, or mammaliferous crag, the red crag, and the coralline, or white crag. The former, which is partly of freshwater and partly of marine origin, shows a molluscan fauna of a decidedly northern type, and has at its base a bone-bed in which mammalian remains occur in considerable quantities. The red crag takes its name from the colour of its sandy beds, and likewise contains a bone-bed in which the fossils are mainly converted into phosphate of lime, and are thus valuable as a source of artificial manure. Although its molluscs are generally of a northern type, this feature is less marked than in the Norwich crag. The lowest, or coralline crag, which is generally of a light colour, takes its name from the number of species of polyzoa found in these beds; its molluscan fauna indicating warmer conditions than those prevailing during the deposition of the upper members of the series.

One of the features of the mammalian fauna of the crags is the occurrence of remains of mastodons, which are quite unknown in the higher beds, and the comparative rarity of true elephants; while still more noticeable is the abundance of the remains of cetaceans, referable to many species and genera. Although some of the crag mammals belong to existing species, the great majority are extinct, and a small proportion belong to genera no longer existing. It is probable that the greater number of the mammals found in these beds belong to species which were living during the time of their deposition, although a few may have been derived from antecedent Miocene beds. Certain specimens are, however, met with which have clearly been washed out from the London clay or other older Tertiary formations; and these, which may generally be recognized by their water-worn condition, will be omitted from our survey. Although the mammals obtained from the different crags are by no means always the same, it will be convenient to treat of the whole series collectively.

Among the most difficult fossils to determine specifically are detached teeth of the cats, and certain such specimens from the red crag, which have been regarded as indicating an extinct species, are so like the corresponding teeth of the leopard that it would be hazardous to say they do not belong to that animal, although, on the other hand, it would be equally rash to say positively that such was the case. Whether a sabre-tooth occurs in these deposits is uncertain; but there is no doubt as to the existence in that epoch of the striped hyæna (*Hyæna striata*), of northern Africa and India, as several well-preserved teeth have been obtained from the red crag. The occurrence of this species in the crag, and its replacement in the forest-bed and cavern-period by the spotted hyæna, is one of those remarkable facts in distribution which we have at present no means of explaining. Both the wolf and the fox appear to date from the period of the red crag, while the polecat apparently occurs in the still earlier coralline crag. The common otter seems, however, to be of more modern origin, since a member of the same genus from the Norwich crag, and a second from the red crag seem to be both extinct. By far the most remarkable of the red crag carnivores is the giant panda (*Ælurus anglicus*), at present known only by an upper molar and a fragment of the lower jaw with the last tooth, since the genus to which it belongs is represented elsewhere solely by the panda or cat-bear (*Æ. fulgens*) of the south-eastern Himalaya. The existing panda, which is an animal of about the size of a fox, with a bright red coat and long bushy tail, is of especial interest as being the sole Old World representative of the raccoons, and is characterized by the peculiarly complex structure of the upper molar teeth and the remarkably curved form of the lower jaw. Since the crag fossils present precisely the same character, there can be no doubt of their having belonged to an animal of the same genus, which was, however, double the size of its existing representative. That a creature so isolated and peculiar as the Himalayan panda should be represented by a closely allied but gigantic species which lived in Britain in company with the wolf and the fox, is one of the most unexpected facts revealed by palæontological investigation.

Fig. 2.—Last upper molar tooth of the Hyænarctus.

So far as can be determined there is no evidence of the existence of true bears in the crag, and it is probable that both the cave-bear and the brown bear do not antedate the forest-bed, although an extinct species occurs in the upper Pliocene of the Continent. In the red crag the place of these animals is taken by a huge carnivore known as the hyænarctus, which was in many respects intermediate between bears and dogs, the upper molar teeth, as shown in the accompanying cut, being shorter and squarer than those of the former, while the carnassial or flesh-teeth were of a cutting type more like those of the latter. Species of the same genus occur in the Pliocene and Miocene formations of the Continent, as well as in the

Indian Pliocene. A walrus (*Trichechus huxleyi*), apparently identical with the forest-bed form, as well as two species of seals, one of which is assigned to an extinct genus (*Phocanella*), complete the list of the carnivores of the red crag; and it may be added that the occurrence of the former is not out of harmony with the climatic condition indicated by the molluscs.

Neither oxen, musk-ox, sheep, or goats are known from the crag; but a gazelle, apparently extinct, from the Norwich crag is of considerable interest as indicating the probable existence in England at that period of open, more or less desert plains like those frequented by the majority of the existing members of that group. In contrast to this paucity of hollow-horned ruminants is the abundance of stags, which are especially common in the Norwich crag, and for the most part belong to types unlike any now existing, although Falconer's deer (*C. falconeri*) was near akin to the fallow deer. Among the most peculiar is a species named *C. verticornis*, characterized by its short and thick antlers, in which the cylindrical brow-tine curves downwards over the forehead, while above it are two oval tines, and superiorly the beam becomes flattened and expanded into a crown of two points. The pigs were represented by two extinct species, one of which was nearly allied to, if not identical with, the gigantic *Sus erymanthius* from the Pliocene deposits of Attica; while the smaller one has been identified with another continental species known as *S. palæochærus*.

Among the odd-toed ungulates, true horses seem very rare, although Steno's horse, alluded to above as characteristic of the forest-bed, has been recorded from the Norwich crag. Three-toed horses of the genus *Hipparion* were, however, common in the red crag; their upper molar teeth, as shown in the accompanying figure, being always distinguishable at a glance by the isolation of the antero-internal from the enamel-folds of the centre of the crown. The red crag rhinoceroses are quite distinct from those of the overlying beds, one being identical with the hornless *Rhinoceros incisivus* of the continental Pliocene, while it is possible that a second may be the same as a two-horned form (*R. schleiermacheri*), which is apparently nearly allied to the living Sumatran species, having, like the hornless forms, large tusks in the lower jaw. The occurrence of a tapir in the red crag assists in explaining the present anomalous distribution of these animals; one species of which is Malayan, while all the rest are South American. Although the straight-tusked elephant occurs in the Norwich crag, while the southern elephant dates from the subjacent red crag, the commonest proboscideans of the period under consideration were mastodons, which, it is scarcely necessary to mention, differ from elephants in the much lower crowns of their molar teeth, which are surmounted by low tubercles, frequently arranged in a small number of transverse ridges, separated from one another by more or less completely open valleys, this type of tooth being much more generalized than that of the elephants. In one of the crag mastodons (*M. arvernensis*) the tubercles of the molars were arranged alternately and the lower jaw was short and devoid of tusks; in a second (*M. longirostris*) the same tubercles were arranged in transverse ridges, with their worn summits showing a trefoil pattern like those of the hippopotamus, the lower jaw being at the same time greatly produced and armed with a large pair of tusks; while in the third (*M. borsoni*) the ridges in most of the teeth were three, instead of four in number, and retained much less distinct evidence of their constituent tubercles.

FIG. 3.—Left upper molar tooth of Three-toed Horse (*Hipparion*).

The rodents need not detain us long, but the giant beaver of the forest-bed was sparingly represented in the Norwich crag, while a smaller member of the same genus (*Trogontherium minus*) is found in the subjacent beds; the only other named rodent being the extinct vole referred to above, which ranges downwards from the forest-bed to the Norwich crag.

The whales and dolphins of the crag are so interesting that they would afford ample material for an article by themselves, and can, therefore, receive but scant notice in the limits of space available. Among the whalebone group there appear to have been no less than four species of right whales, one of which (*B. affinis*) resembled the Greenland whale, while a second (*B. primigenia*) was more nearly allied to the southern right whale, and a third (*B. balænopsis*) was characterized by its small dimensions. Humpbacks (*Megaptera*) were likewise well represented, as were also the finners (*Balænoptera*); while an extinct genus (*Cetotherium*) allied to the last contains several species from the crag. It may be mentioned here that all these whales are represented by the shell-like tympanic bones of the inner ear, which differ remarkably in form in the various genera, and thus form unerring guides both for generic and specific determination. Another type of these bones, remarkable for its egg-like form, serves to differentiate yet another extinct genus (*Herpetocetus*) of whalebone whales. Turning to the toothed whales, a remarkable feature in the red crag is the number of teeth indicating the occurrence of large forms more or less closely allied to the sperm-whale, but mostly distinguished by the presence of small caps of enamel. There were likewise smaller forms, one of which has long been known under the name of *Physodon*, although it was only recently that the writer was able to determine from the evidence of a Patagonian specimen that it differed from the sperm-whale in having teeth in the upper as well as in the lower jaw, and thus indicates a distinct and more primitive family connecting the sperm-whale with the dolphins. That a bottle-nosed whale nearly allied to the existing *Hyperoodon rostratus* inhabited British water during the red crag period is proved by an ear-bone in the Ipswich Museum; and the number of beaked whales living at the same time must have been extraordinarily great, from the profusion in which their dense bony beaks occur in these deposits. Most of them belong to the same genus (*Mesoplodon*) as that rare visitor to the English shores, Sowerby's whale; although a few pertain to an extinct genus (*Choneziphius*) characterized by the presence of an unossified tubular perforation running through the centre of the beak. A species of the extinct shark-toothed dolphins (*Squalodon*), together with a killer (*Orca*), black-fish (*Globicephalus*), dolphin (*Delphinus*), and bottle-nosed dolphin (*Tursiops*), completes the list of crag cetaceans. It may be added that the sirenians, that is to say the order to which belong the living manati and dugong, are represented by a skull of the extinct genus *Halitherium* from the red crag, but it is quite possible that this specimen may have been washed out of Miocene beds.

Although the fauna of the crag would have appeared strange and foreign even to an inhabitant of Britain during the early historic period, when the wolf, bear, aurochs, and beaver still lingered in our islands, could a cave-man have seen Britain as it existed during the period of the crags, he would not have found the fauna very different to the one with which he was acquainted, mastodons

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taking the place of elephants, and the hornless rhinoceros representing the two-horned woolly species which he had probably been accustomed to hunt.

INSECT SECRETIONS.—V.

By E. A. Butler, B.A., B.Sc.

(*Continued from page* 178.)

AMONGST butterflies and moths, the exciting moment when the most wonderful change in their whole history takes place—the moment when they throw aside the deathlike torpor of the limbless chrysalis and take on, to all appearances suddenly, a complete locomotive equipment consisting of six legs and four wings—is an occasion which, in consequence of its exceptional requirements, is fruitful in the production of characteristic liquids. When a chrysalis is enclosed in a cocoon, it is obvious that some substance must be produced by the newly emerging insect, which it may use as a means of escaping from its enveloping shroud of silk. It has no biting jaws, as it had just before it entered on the pupa stage, so that gnawing its way through is altogether out of the question, and it must make its escape by using some solvent which will chemically affect the silk, and either loosen its component threads at the spot where the exit is to be made, or absolutely dissolve them. In our articles on "Curious Cocoons," we have already pointed out that it has recently been discovered that, in one instance at least, this solvent has the remarkable characteristic of being a strong caustic alkali—none other, in fact, than potash itself. We refer to the instance of the puss moth, whose exceptionally hard cocoon necessitates an equally powerful solvent. That an alkaline fluid was produced by this insect on its emergence was indeed noticed nearly fifty years ago, but its exact nature was not determined until quite recently. Analogy would lead us to conclude that a liquid of somewhat similar nature, or at any rate of similarly corrosive action, must be produced by other moths which enjoy the shelter of closed cocoons during their period of lethargy.

Those who have kept caterpillars, and watched the changes through which they pass, are familiar with the fact that a newly emerged butterfly or moth discharges a quantity of a reddish fluid from its digestive tube, so that the ground in the immediate neighbourhood of such an emergence, and the various objects around, including often the old chrysalis shell, become bespattered with drops of coloured liquid, which soon dry up and leave behind a reddish or orange powdery deposit. This liquid is of an acid character, since it reddens blue litmus paper when placed upon it. It is often shot out in considerable quantity and with great force, especially when the insect is disturbed before it has become properly prepared for its new style of life.

Not only does this discharge take place when a chrysalis becomes a perfect insect, but a similar incident often occurs when the caterpillar becomes a pupa. The contents of the alimentary canal are then voided in a semi-fluid condition, though under ordinary circumstances the excrement is compact, and comparatively dry and hard. In the case of the emperor moth (*Saturnia carpini*), Mr. Bateson has made a careful examination of this discharge, specially with a view of determining its relation to the colour of the cocoon. While still contained within the alimentary canal the liquid is green, but shortly after being ejected it becomes reddish-brown. Microscopically examined, it is seen to consist of a coloured liquid containing partially digested food. If it be filtered through blotting paper, a clear green liquid is obtained, which turns reddish-brown in the course of a few minutes. This is no doubt a chemical change due to oxidation, resulting from exposure to the air, as the following experiments tend to prove. If a little be placed on a glass plate, the outer layer may be seen to have changed colour, while the lower part, being out of contact with the air, still remains green. If again the liquid be placed in a tube, and then shaken up with air, the darkening process is accelerated. Yellow nitric acid, a body which easily yields up oxygen, destroys the green colour at once, and turns the liquid reddish-brown. The question whether this substance is a true secretion, or merely a product of the digestion of the food, is not so easy to determine, but that the latter is its true source seems probable from the fact that no such colouring matter can be discovered in the walls of the intestine, though one would expect to find it there if it were a true secretion from glands on the walls.

But though these coloured liquids ejected by caterpillars just before pupation may not really be connected with any special secretory organs, there is an instance of a remarkable product which has been traced back to a special part of the alimentary canal, and is thus shown to be of the nature of a secretion. The product referred to is a powder formed by the caterpillar of the lackey moth (*Clisiocampa neustria*), a well-known flabby creature, striped with reddish, orange and blue, and often found abundantly on whitethorn hedges. This caterpillar fashions for itself a delicate white silken cocoon, of loose and semi-transparent texture. The part immediately surrounding the insect is more compact than the rest, but even that remains sufficiently thin for the outline of the chrysalis to be faintly traced through it. When the caterpillar has completed its task, it discharges from the end of the alimentary canal a quantity of a pale yellow powder, which looks a good deal like flowers of sulphur. This powder, lodging in the meshes of the silk, of course renders the cocoon a good deal more opaque, and thus may perhaps be a source of protection to the insect.

Mr. Poulton recently examined this powder chemically and microscopically, and found that it consisted of minute crystals of carbonate of lime. Dissections of the caterpillars showed that the ultimate source of the powder was the malpighian tubules, the long thin tubes that open into the intestine just behind its junction with the stomach. It is, of course, initially obtained from the food, and apparently accumulates in the tubules till the end of the feeding life, when it is got rid of and made to subserve a possibly useful function in giving greater opacity to the cocoon. This would be of little avail if the creature remained in the chrysalis condition throughout the winter, for the winds and storms of that season would very soon shake all the powder out. But as the insect remains a chrysalis only for a very short time, the obscuration caused by the powder may perhaps be of some slight advantage to it.

Like the skunk amongst mammals, many insects are distinguished for the strong odour that attends them, and that usually proceeds from fluids which they secrete. In a few instances the odour is agreeable to the human olfactory sense, but generally it is quite the reverse. These odours may in some cases be a means of sexual attraction, and in others the liquids which produce them may cause the insects to become nauseous and unpalatable, and so protect them from their enemies. But it would be unsafe to conclude that scents which are agreeable to human beings are also necessarily a source of attraction to the lower animals, and in fact often the very reverse is the case, for many insects are strongly attracted by decaying

matter, which to us smells most foully, and if this be so with what we call evil scents, the same may be true of other kinds. It is not, therefore, a legitimate inference that sweet scents are always possessed by insects as a means of attraction, but that evil odours are a means of protection. But, nevertheless, it may well be the case that the substance which yields the odour may be of such an irritating nature as to make both fragrant and malodorous insects unpalatable.

Two orders of insects are particularly noteworthy for the odours that attend them—the Hemiptera, in one division of which, viz., the Heteroptera, or dissimilar-winged bugs, the majority are supplied with a more or less penetrating and disagreeable smell, and the Coleoptera, or beetles, a good many members of which exhale odours, agreeable or otherwise. Outside of these two orders we only meet with occasional instances of odoriferous insects, such as the cockroaches amongst the Orthoptera, the lacewing flies amongst the Neuroptera, and the caterpillar of the goat moth amongst the Lepidoptera. Mr. Robson thinks that the female swifts, which are nearly related to the goat moth, also have the power of exhaling a faint odour which is attractive to their mates, and that the fluttering of their wings which takes place while they are waiting for a partner helps to disseminate the odour.

Amongst the Hemiptera-Heteroptera, or bugs, there is a wonderful uniformity about the nature of the scent, as well as of the organs by which it is secreted. In almost every instance amongst the scores of odoriferous species we possess in this country, the odour resembles that of the bed-bug, so that even in this respect there is a family likeness which enables the entomologist at once to refer them to their proper order. As a rule, the larger the insect the more powerful the scent, but that is not universally the case, and amongst the more delicately constructed species, irrespective of size, the smell is often so feeble as to be practically imperceptible to human sensibilities, though of course it does not follow that it is imperceptible to the more acute senses of the insects themselves. The glands by which the fluid is secreted lie on the under side in the central line of the body, and open between the third pair of legs. The form of the orifice and its surroundings varies in the different species, so that it can sometimes be used for classificatory purposes.

The larger, hard-bodied bugs, whose curious shape has gained for them the popular name of "bishops' mitres," often smell very strongly, and so penetrating and persistent is the odour that if the substance stains the fingers, the odour is difficult to eradicate, and clings to them even after washing. If after touching them the finger be applied to the tongue, a burning and very irritating sensation is felt. Most of these larger species are not very common with us; they are met with on trees and bushes of different kinds, and are to some extent indifferent as to diet, feeding on the sap of trees or the blood of insects. As they do not occur in large numbers together, their very strong scent is hardly noticed until one comes within two or three feet of them, but then it is found to be very powerful, and if the entomologist happens to have included one of them in his net as the result of sweeping amongst long herbage, he is sure to be made acquainted with the fact by his nose, even if his eyes are not acute enough to single out the offender at once from amongst the rest of his captures. The smell of the bed-bug is also peculiarly nauseous, though no doubt our dislike of the scent is in this case accentuated by the knowledge of the uncleanly conditions which are indicated by the presence of the insect. But the worst offender in the whole order is a field species which is often to be met with in profusion amongst grasses and other long herbage. It is called *Leptopterna dolobrata*; the male (Fig. 14) is a very handsome insect, and differs a good deal from the female. It is long and narrow, very variable in depth of colour, but with the fore parts yellow marked with longitudinal black bands, and the upper wings orange variegated with dark streaks. The female is much paler, being greenish-yellow, and rarely has her wings fully developed. The scent of this insect is most sickening, especially that of the female, and I have passed by places where the air has been strongly impregnated with the smell, though the insects were not nearer than ten or twelve feet off, and many of them much further than that. It is hardly likely that an insect so nauseous can have many enemies.

FIG. 14.—*Leptopterna dolobrata* (magnified two diameters).

The evil repute of this order of insects is to some extent redeemed by one species, a sand- and heath-loving creature, and no very distant relation of the bed-bug, itself. This insect (*Coranus subapterus*) is very elegantly marked with a cool grey, and smells strongly with a fragrance which reminds one of pears. It is exceedingly well protected by its great similarity in colour to its surroundings, so that possibly the smell in this case may be a guide to its mates as to its whereabouts.

Amongst the Coleoptera, or beetles, there are species equally renowned for their scent. The beautiful green tiger beetles, which are such attractive adornments of sunny banks in early summer, exhale, when captured, a powerful and very agreeable odour, something like that of sweetbrier. Considering that the insects are fiercely carnivorous, this is perhaps hardly what was to be expected. That scents such as this are indeed independent of the nature of the food is shown again in the musk beetle, a very large dark-green insect with extremely long antennæ. The smell of this creature is not unlike that of the tiger beetle, and equally agreeable, but its food is totally different, for the larva is an inhabitant of tree trunks, the solid wood of which forms its daily diet. Thus we have a predaceous beetle and a wood-feeder producing similar agreeable scents, while other members of the family to which the musk beetle belongs, though of quite similar habits, are devoid of smell altogether.

In all the cases already noted the fluid secreted is so extremely volatile that it is never seen to issue from the insect, and its presence is only detected by the smell, but in the cases now to be noticed the liquid is not so volatile, and its emission is itself one of the most objectionable features of the insect, even when the scent is not decidedly disagreeable. The various species of ladybirds are well known to emit from their mouth and other parts of the body a yellow, oily, acrid liquid, which has a very strong and disagreeable smell. This habit is paralleled, and in some cases exceeded, by members of the *Chrysomelidæ*, or golden apple beetles. The most noteworthy offender in this group is a shining metallic blue beetle with red wing covers, called *Lina populi*. Its larva, which feeds on poplar leaves, has two conical warts on the fore part of its body, and two rows of smaller tubercles on the back and down the sides, and from all these warts, as well as from the mouth and the joints of the legs, a horribly fœtid, whitish fluid exudes when the creature is alarmed. Notwithstanding the disgusting nature of these secretions, or rather, perhaps, we should say *because* of this quality, they were formerly considered to have valuable medicinal

properties, and are said to have been used as a specific against toothache.

Closely allied to the golden apple beetles, and indeed belonging to the same family, is the well-known "bloody-nose beetle" (*Timarcha tenebricosa*) (Fig. 15), which is a very common insect on wayside banks in limestone districts. It is a large and heavy, slow moving, very convex, black creature, faintly tinged with blue, with broad feet, which are of great service to it as it slowly crawls over the herbage. Its popular name arises from its disagreeable habit of exuding from its mouth and from the joints of its limbs a clear red liquid, which reminds one somewhat of the colour of the blood of a vertebrate. Here, again, one can only imagine a protective function in this liquid. The appearance is the most objectionable feature of this secretion, there being no very strong smell attached to it. But such is not the case with the predaceous ground beetles, or *Carabidæ*, all of which pour out a fœtid black or brown liquid from the mouth when handled. A similar habit is exhibited by many carrion feeders, and in this case, as might be expected from the nature of the food, the liquid is still more foul.

Fig. 15.—Bloody-nose Beetle (*Timarcha tenebricosa.*)

The evil odour of scavenger beetles, however, does not always proceed from the mouth. Among the rove beetles there are many species that have a most repulsive odour, and in their cases the glands are often situated at the tail. The largest species of the group, *Ocypus olens*, the "Devil's coach-horse," may be taken as an example. It is a long, dull black creature, shaped something like a gigantic earwig, attaining a length of upwards of an inch. It is extremely active and remarkably courageous and aggressive. It may often be seen running about at the foot of brick walls, or by the side of pathways, where it is provided with subterranean cavities for retreat if necessary. But it is always prepared to show fight to any object, however large, and if interfered with, at once faces the intruder, and cocking up its tail, and raising its head, glares open-jawed defiance at its opponent with an aspect of the utmost ferocity. At the same time two milk-white vesicles make their appearance at the tail, standing out in bold relief on the dead black background of the body. A very disagreeable odour proceeding from these vesicles is soon perceptible, and makes one still less inclined than before to press one's attentions on so formidable a being.

The larger water beetles, again, emit an extremely fœtid fluid when handled, but of the whole tribe, none perhaps is so repulsive as the little shining whirligig beetles (*Gyrinidæ*), whose mazy gyrations on the surface of still water must be familiar to everyone. These little, highly polished creatures have the power of exuding an oily milk-white liquid from various parts of their bodies, which, spreading over their shiny black surface, gives them the appearance of having been dipped in milk. So acrid is this liquid that the beetles must be an extremely undesirable article of diet, and, as they spend their life at the junction of two transparent media, air and water, each of which is inhabited by predaceous and insectivorous beings, their villainous secretion no doubt serves them in good stead against both sub-aquatic and aërial foes, as well as possibly improving their means of flotation.

One of the most remarkable of the numerous secretions formed by beetles is that of the bombardier (*Brachinus crepitans*) (Fig. 16). This is a small beetle with red head, thorax, and legs, and bluish-grey wing covers. Itself predaceous, it is nevertheless hunted by larger species which desire to prey upon it, and as speed and agility are unavailable against its larger and more active pursuers, it has developed a sort of battery of stern-chase guns, by the aid of which it can effect a Parthian retreat, and bring about the discomfiture of its foes. When attacked it elevates its tail, and discharges therefrom towards its assailant a small quantity of a liquid which instantly vaporizes with a slight explosion, and forms a bluish-white cloud. The expulsion of the liquid appears to require a certain amount of force, and so volatile is it, that if the insect be killed by plunging it into boiling water, the heat volatilizes the liquid while it is still within the abdomen, and causes the latter to swell out to a considerable size. This insect is to be found not unfrequently in the south of England, under stones, by the banks of streams, &c. Its secretion is a strong acid, which acts as an irritant when applied to the skin.

Fig. 16. — Bombardier Beetle (*Brachinus crepitans*), magnified two diameters.

(*To be continued.*)

THE WANDERINGS OF A SUNSPOT.

By E. Walter Maunder, *Hon. Sec. R.A.S., Physical Superintendent Royal Observatory, Greenwich.*

Dr. A. BRESTER, in his interesting "Theory of the Sun," first published in 1888, and to which he has again recently invited attention, speaks of the singular manner in which spots are apt to move forward during the stage of growth. Quoting from Prof. Young, he writes: "Every time a spot undergoes sudden changes it ordinarily advances on the solar surface by making a sort of leap." I do not propose to discuss Dr. Brester's theory—at any rate on the present occasion—but it seems to me that the proper motion of a sunspot deserves a little more particular description than the above sentence supplies, and, if I interpret the phenomenon rightly, it fails to afford Dr. Brester that confirmation of his theory which he supposes.

Forward motion in a spot is certainly the kind of movement which most readily attracts attention. It is a very ordinary phenomenon of a particularly interesting type of group, viz., the "trains" and "streams," to use Miss Brown's nomenclature. A "train" or "stream" is "a group of spots following each other in succession, having nearly the same latitude, but varying in area and form." When these spots are of considerable size and are not closely connected, the group is called a "train." When the constituents of the group are smaller and less widely separated, the group is termed a "stream."

A train or stream frequently shows itself first as a pair of small spots. The preceding spot of the pair will then move forward at a much quicker pace than its companion, and new spots will break out around those first seen, and especially along the line connecting them. The first and last spots grow rapidly, but usually present different characteristics; the leader being circular and sharply defined, with dark central nucleus, whilst the spot in the rear is much more irregular in outline, not so dark in tone, and with a smaller and more broken nucleus. As the leader spot is the more definite and regular, and as it pushes its way quickly forward whilst the rear-guard either halts entirely, or even moves slowly backwards, its motion naturally attracts great attention. This period of forward motion is also very commonly one of rapid growth, and as both phenomena are very frequently observed, it has no

doubt given rise to the idea expressed in the quotation which Dr. Brester makes from Prof. Young.

But though this is typical of the behaviour of a large number of groups, we must not associate the growth and forward motion of the leader spot too closely together, and it certainly is not motion of the nature of a "leap." It will often happen that in a growing "train" the last spot will increase even more rapidly than the leader, whilst the leader will often continue its motion forward at a rapid but equable pace some considerable time after it has reached its greatest extension. Nor is the very opposite phenomenon unknown, viz., that of a recession in longitude during the development of a group.

An actual example will, however, convey much more information than mere general description, and for this we will turn to the last volume of Greenwich *Observations*. Here we find that a simple form of train took its rise on October 16th, 1891 (No. 2325), and, developing rapidly, was observed till it reached the west limb on October 25th. On the first day of observation only two small well-defined spots were seen, their total area only nineteen of the Greenwich units (millionths of the sun's visible hemisphere). By the next day a number of spots were seen, and the total area was one hundred and one units, the increase being principally in the case of the preceding of the two spots of the day before, which had increased from eight to seventy-three units. The third day showed the group at its maximum area of three hundred and twenty units. It now consisted of two great spots. A few spots were seen between the two, linking them as it were together, on the succeeding days, but the first and last spots, the giants of the group, were slowly diminishing the while. By October 23rd the last spot had broken up, and it dwindled with great rapidity, and by October 25th the leader spot alone remained, a solitary spot.

But though the increase in size took place entirely between October 16th and 18th, the drift apart of the two principal spots continued right on to the time of the break-up of the following spot on October 23rd. As the following little table will show, the movement lay almost entirely with the leader, the following spot remaining almost stationary, for the apparent change in longitude near the beginning and end of its career may at least be partly attributable to its growth and decline taking place not quite symmetrically :—

Date. 1891.	Heliographic Longitude. Spot *a*.	Spot *b*.	*a*—*b*.
October 16	330·1°	327·3°	2·8°
,, 17	331·1	328·0	3·1
,, 18	333·2	328·1	5·1
,, 19	334·2	327·5	6·7
,, 20	335·6	327·5	8·1
,, 21	336·5	327·6	8·9
,, 22	337·2	327·4	9·8
,, 23	337·3	327·1	10·2
,, 24	337·8	327·7	10·1

In groups which have been longer under observation than the above, it has sometimes been the case that the disappearance of the following portion of the group has been followed by a backward drift of the leader spot. In the present case the group died out whilst in the unseen hemisphere, but another group, which appeared in 1891, shows this retrogression in a slight degree. The group (No. 2255) was a fine train at its first appearance on July 8th. The forward impulse was still active in the leader, a well-defined circular spot, as the following longitudes, taken on July 9th and the succeeding days, sufficiently show :—177·0°, 178·8°, 179·7°, 180·3°, 181·6°, 181·8°, 182·5°. Here, however, its progress stopped. The retinue of small spots that had attended it hitherto had all but disappeared by the following day, and though the leader itself continued still to grow until it reached the west limb on July 20th, the longitudes recorded for it show no stable progress, but are accordant almost within the limits of error of observation for so large a spot, the mean place being 182·4°. A fortnight later the group was again seen at the east limb as No. 2277; the retinue had entirely disappeared, and the leader of the former apparition appeared alone. The longitude had scarcely altered from that it had on July 20th, being 183·1° as against 182·6°; the advance during an entire fortnight amounting only to half a degree. It was now slowly diminishing in size, its areas on succeeding days reading as 221, 221, 198, 190, 195, 185, 185, 177, 162, 140, 172, 107, and 104. In strict correspondence with this diminution in area was a decline in longitude, the readings for the same period being 183·1, 182·7°, 182·7, 182·5°, 182·4°, 182·2°, 181·9°, 181·7°, 181·5°, 181·2°, 181·3°, 181·5°, and 181·0°, the ephemeral recovery in area on August 14th being accompanied by a feeble but longer-lived return in longitude.

A more complicated movement was witnessed in the group numbered at its successive returns as 2256, 2278, 2294, and 2311. Nothing is more striking in the case of a considerable disturbance than to see it repeat itself as it were in another latitude, and an active train will often be accompanied by a feebler copy of itself a few degrees north or south. An outbreak of the first magnitude, indeed, will reproduce itself in several directions, and will be both preceded and followed by small groups on the same line of latitude, whilst other groups will form between it and the equator, but on the same meridian.

In the present instance, groups 2255 and 2256 both lay on the same meridian and were of very equal dimensions; the more northern group, as of longer duration than its companion, having perhaps the better right to be considered the principal. As in the October group (No. 2325), the train consisted principally of two great spots, and the second of these remained almost stationary, its longitudes reading as 168·5°, 168·2°, 168·2°, 168·0°, 168·1°, 168·3°, 168·4°, and 168·4° on July 11th and the succeeding days. The leader during the same period had shown a slight tendency to advance, its position varying as follows :—174·4°, 174·8°, 174·9°, 175·6°, 176·3°, 175·7°, 175·7°, 176·3°. The leader attained its maximum on July 12th, the rear-guard on July 13th, but the latter had broken up by July 15th,* and it dwindled rapidly. Its decay was accompanied by a check to the advance of the leader, and by a sudden increase in size, but after the disappearance of the rear spot the leader again moved forward, its longitudes for July 18th, 19th, and 20th being 176·3°, 176·9°, and 177·8°, but its area again steadily diminishing. Here, then, two periods of contraction were associated with a steady advance, but a sudden expansion with a halt and slight retrogression.

At its return, as group 2278, the leader was found in longitude 179·7°. It had considerably increased in size—from one hundred and eight to three hundred and five units—and was alone but for the presence of a faint area apparently recently separated from its penumbra. During this apparition the spot steadily moved backward in longitude, and, with some slight irregularities, on the whole decreased in area. The longitudes ran 179·7°, 179·0°, 178·3°, 178·1°, 177·4°, 177·2°, 177·0, 176·8°, 176·8°, 176·5°, 176·1°, 175·9° and 175·3°.

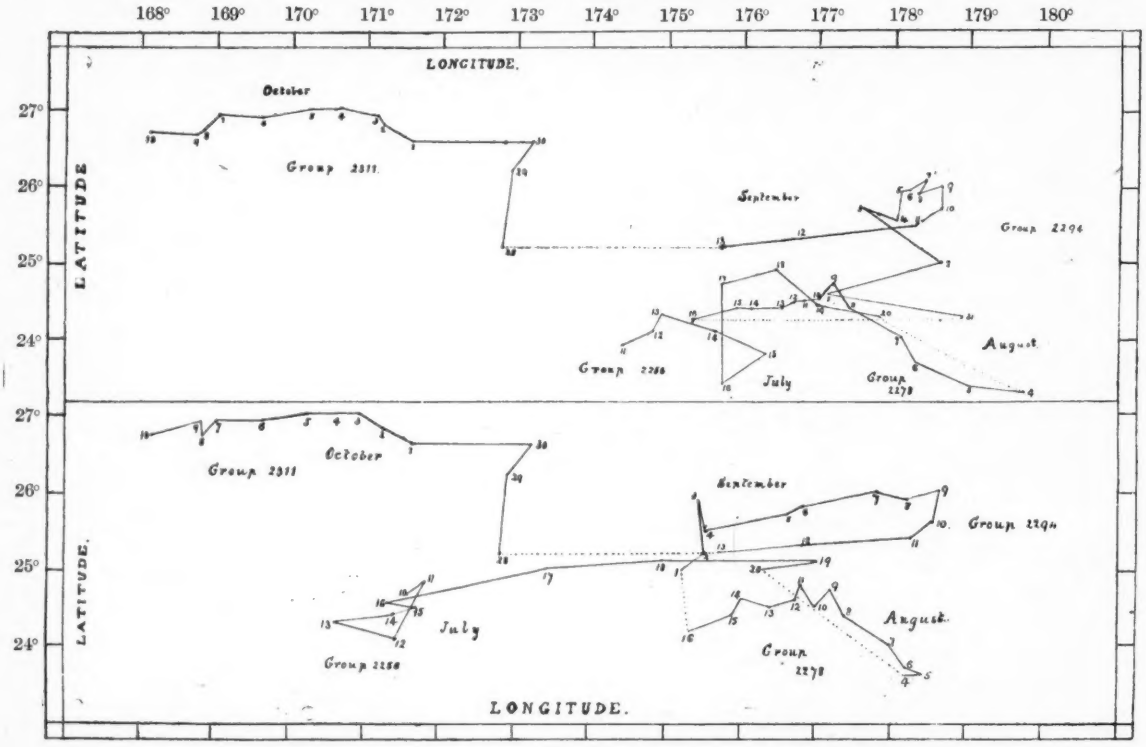
The group was seen during the two next rotations; from August 31st to September 13th as No. 2294, and from

* The letter *b* for the rear spot is retained after its division in the Greenwich Results for its preceding portion.

September 28th to October 10th as No. 2311. As No. 2294 it pursued an erratic course, moving irregularly backwards and forwards over a small area, and was last seen at the west limb of the sun on nearly the same meridian as that on which it had been first seen on the east limb. But during the next fortnight, whilst in the unseen hemisphere, it had drifted backwards at a very rapid pace, a drift which still continued during its final apparition as No. 2311, and the group first seen on July 9th in longitude 175·1° was last seen on October 10th in longitude 168·1°.

The accompanying diagram exhibits separately the motion of the circular leader spot taken by itself, and of the centre of gravity of the entire group. The minuter irregularities are possibly due to errors of observation, a discrepancy of one or two tenths of a degree being readily admissible in the estimation of the centre of a spot some

CURVE SHOWING DRIFT OF THE LEADER SPOT.



CURVE SHOWING DRIFT OF THE CENTRE OF GRAVITY OF ENTIRE GROUP.

backwards along a course as even and straight as it had previously been erratic.

It would be tedious rather than instructive to multiply examples of this forward and backward movement of spot groups, which is extremely typical of the greater and more long-lived disturbances. The instance selected is an ordinary one, and might be matched by the dozen. But to my mind this extension of a group in longitude, till from being one or two degrees in length it becomes ten or twelve degrees, the sympathy often manifested between the extreme spots of a much extended group, and the tendency of a group to return to its original meridian as it approaches dissolution, are plain indications that the cause of the outbreak is something very deeply seated in the sun, whether the actual spots be deep or not.

In other words, in spite of the obstacles which the solar

three degrees in diameter, and still more so in the computation of the centre of gravity of an irregular group which sometimes straggled over more than ten degrees. But it would rather appear that they are real, for it will be noted that, except during the first development of the group, the curve for the entire group is actually smoother than for the leader alone. In other words, the waxing and waning of the spots in the after part of the group, and their oscillations of position, were so instantly responded to by a partially compensating motion of the leader, that the group, considered as a whole, kept a more even course than the single spot. This was especially the case during the third rotation, when the leader followed a particularly zigzag path so long as it had a train of attendants. When these had all disappeared it moved

gravity and the rapid increase of temperature with depth place upon vertical disturbance in the sun, vertical disturbance and disturbance from a great depth is just the very thing which the greater sunspots evidence.

The groups we have taken as examples were only of the third or fourth order of magnitude, yet they furnish us with instances of spots with areas of two hundred or three hundred millions of square miles, moving at a speed of from two hundred to four hundred miles an hour. There can be no question of a calm atmosphere where movements of this order are in frequent progress. Our wildest tornadoes would appear but as zephyrs in comparison. The argument, therefore, that the solar atmosphere must be quiescent, because the external causes of storms and cyclones at work upon the earth are absent there, is not

valid. Whatever the cause, disturbances of greater energy, and on a vastly greater scale than anything we witness here, are manifestly in continual operation.

One other point should be noted. The forward motion of the group was considerably greater than the longitudes given above would indicate, for they were computed with an assumed rotation period of 25·38 days; but this period corresponds, according to Carrington's law, to a latitude of 15°. For spots in north latitude 25°, the daily angular rotation should be 831′ instead of 851′, and the group on October 10th should have been some 27° behind its place on July 10th, instead of not quite one-tenth of that distance. The movements of the group in a forward direction were therefore one hundred miles an hour swifter, as compared with the photosphere in that latitude, than the foregoing figures would indicate.

It may also be pointed out, as showing how difficult it is to obtain a satisfactory determination of the solar rotation from the sunspots, that the group in question would give a different value for the rotation period from each of its four apparitions and from each of the three periods during which it is in the further hemisphere. And that, further, we should get different periods from the group as a whole, and from the stable and well-defined leader spot, which always constituted its principal member. Two of these values, as given by the leader spot, would correspond closely to the theoretical rotation for the latitude; the others would all be much shorter, as this table shows:—

Limiting Dates.	Rotation Period. Entire Group.	Leader Spot.
July 11–July 20	24·52 d.	24·71 d.
July 20–August 4	25·15	25·15
August 4–August 16	25·84	26·06
August 16–September 1	25·38	25·18
September 1–September 13	25·29	25·59
September 13–September 28	25·72	25·72
September 28–October 10	26·12	26·12

This question of the rotation period for different latitudes renders it a difficult matter to trace with certainty an interrupted disturbance. Yet it is not uncommon, when the site of some great outbreak is traced back for two or three rotations, to find that it has for a long time past been the seat of short-lived displays. Thus, the chief group of 1891, No. 2293, had its centre in longitude 221·5° and north latitude 21·8° during its greatest development, August 29th to September 10th. The following table will show how, for several months before, outbreaks of varying importance and duration had been common in the same locality:—

No. of Group.	Limiting Dates.	Long.	Lat.
2293	August 29–September 10	221·5°	+21·8°
2272	August 1–10	222·7°	+18·2°
2254	July 6–17	219·1°	+20·4°
2240	June 17–20	213·9°	+22·1°
2235	June 10–20	199·7°	+26·1°
2222	May 22–25	196·8°	+25·6°
2218	May 16	200·4°	+25·7°
2203	April 19–25	225·5°	+25·5°

Similarly, after the dissolution of the group a number of short-lived groups were scattered over the entire region which it had occupied.

No. of Group.	Limiting Dates.	Long.	Lat.
2306	September 24–October 5	227·4°	+23·2°
2328	October 22–November 2	218·1°	+18·0°
2329	October 23–30	228·2°	+25·9°
2330	October 24–27	225·7°	+19·0°
2335	October 28–November 2	223·0°	+29·4°

Here, again, the final position for the centre of disturbance is nearly the same as the original position, in spite of the high latitude. The real fountain of the formation of the spot, therefore, would appear to have rotated with a speed which was independent of latitude, and which did not greatly differ from the mean period of the spots.

ON THE ORIGIN OF THE GOLD IN QUARTZ VEINS.

By HENRY LOUIS, *Assoc. R.S.M., F.I.C., F.G.S., Mem. Amer. Inst. Min. Eng., etc. etc.*

WHENEVER we find rival sets of theories held by acknowledged authorities in any branch of science, one of the best services that can be rendered to that science is the collation and criticism of these theories as applied to some one closely defined subject. In no other way can the weakness and strength of the respective positions be as clearly seen, and the probabilities in favour of each as successfully studied.

The general question whence the various substances have come that constitute the filling of mineral veins is still to-day, in spite of the immense amount of work that has been bestowed upon it, one of the most debatable within the whole range of geology. Whilst no one nowadays doubts that the filling up of the fissures, which constitute veins, has been brought about by aqueous or hydro-thermal agencies, and that the various minerals have been introduced in solution, opinions vary greatly as to the direction whence these mineral solutions have come: they may have entered the open fissure from above or from below, or may have been forced in by pressure or by capillary attraction through the pores of the rocks that form the walls of the fissure. There are accordingly three main schools of theorists—the descensionists, the ascensionists, and the lateral secretionists. Prof. Lobley has ably sketched the theory of the origin of gold in quartz veins from the descensionists' point of view, and it should prove a profitable and an interesting task to now attack the same problem from the opposite standpoint, and to briefly summarize what may be considered the case for the opposition.

It is hardly worth while to insist upon the primary point that gold, like other minerals, has been deposited from solution. Prof. Lobley has accumulated a considerable body of negative evidence on this head, his proofs resting upon the fact that gold does not exist within regions of known volcanic action. This evidence is hardly, however, as satisfactory as it might be; first of all because it is negative, and secondly because there are at any rate two well-known and oft-quoted localities—Sulphur Bank, California, and Steamboat Springs, Nevada—where gold may actually be traced in process of deposition, both of which offer unmistakable evidence of volcanic phenomena in the shape of hot mineral waters and gases. According to some authorities, too, the famous Mount Morgan Mine in Queensland is simply a geyser deposit, though it is but right to say that this theory has by no means passed unchallenged. I recently attempted to obtain some more direct proof of the aqueous origin of vein gold, and for this purpose compiled as complete a list as possible of all minerals known to accompany gold in auriferous veins. ("The Mode of Occurrence of Gold," *Mineralogical Magazine*, Vol. X., No. 47, p. 241.) This list comprised no less than seventy-seven mineral species; fully two-thirds of these, however, are beyond doubt decomposition products of others, which had as clearly been the minerals

primarily accompanying the deposition of the gold. Of the entire list, however, there was not a single one that is not well known to be producible by deposition from solution, whilst the true volcanic series are conspicuously absent. After all, however, the soundest argument on this point is from analogy, and if there were no other evidence forthcoming, it would yet be safe to conclude that gold, like the other constituents of mineral veins, has found its way into them in solution. When we find crystalline particles of gold in the midst of a vein filled with crystalline quartz, which we know to have been deposited from solution and not injected in a state of fusion, the inevitable conclusion is that the gold, too, was precipitated from solution, and probably even from the same solution as that which held the quartz dissolved. It is therefore satisfactory to be able to confirm Prof. Lobley's views as to the non-igneous origin of gold by means of a totally different line of argument.

With respect, however, to Prof. Lobley's next step, in which the ocean is looked upon as the source of this gold, the proposition becomes far more open to debate; whichever view we now take, there are difficulties on every side, and the problem assumes such a degree of complexity that its complete solution in the present state of our knowledge is out of the question. It is just possible to suppose that sea water could find its way directly into fissures of the earth's crust; nevertheless, direct deposition of the gold from its solution in sea water is pretty well out of the question. In the first place, it is rather difficult to conceive of any system of circulation by which sea water should directly find its way into fissures that were being at the same time filled with a deposit of silica from other sources. Quite apart from the scientific interest of the question, the practical conclusions that would follow from the acceptance of this theory are so far-reaching that they cannot be assented to without the strongest possible proofs. It is fairly clear that if the gold of mineral veins were derived directly from the sea—that is to say, if the descensionists' theory in this form is the correct one—the upper parts of gold veins would be the richest. It is quite true that there is frequently a superficial enrichment of auriferous veins near the surface, due to combined physical and chemical causes, to the concentration, in this portion of the reefs, of the gold derived from the degradation in time past of still higher-lying portions now denuded away, such degradation having, of course, occurred subsequently to the consolidation and upheaval of the vein, together with the surrounding strata. It is also true that the upper portions of reefs are mostly richer in free gold than the lower-seated portions, but this again is only due to the oxidation by atmospheric agencies of the previously existing pyrites with which the gold was intimately combined. The total tenour of gold in the vein is not necessarily affected by this latter change, and upon the whole there is no evidence whatever that gold veins become progressively poorer as we go down deeper upon them. Practical gold miners are fond of saying that gold reefs improve in depth, but practical gold miners are a sanguine race, and it seems but too probable that in the majority of cases it is the "wish that is father to the thought." Instances can, no doubt, be quoted where gold mines, like other mines, have improved in depth, but this must by no means be interpreted into a general law. The richness of gold reefs varies in their vertical as it does in their horizontal extension, but not regularly; in the present state of our knowledge it would be unsafe to predicate more.

According to Prof. Lobley's view, however, sea water is not the direct but the indirect source of the gold of quartz veins. If we admit as proven that sea water contains gold in solution—and the balance of evidence appears, perhaps, to be in favour of this view, although it is by no means easy to speak with certainty when such minute quantities are in question*—the gold most probably exists therein as a haloid salt, possibly as a double chloride of gold and sodium or potassium. This, although one of the most stable salts of gold, is nevertheless so readily decomposable by every reducing agent, including light and a comparatively low degree of heat, that it would be quite inconceivable that metallic gold should not be deposited from this sea water, together with the sedimentary rocks forming on the sea bottom, if it is allowable to take the ordinary laboratory reactions of gold salts as our guide. Modern chemical research has, however, shown that the effect of mass action is too important to be disregarded, and that solutions of extreme tenuity are subject to laws differing widely from those governing the ordinary solutions with which the chemist is in the habit of dealing. Moreover, we are confronted by the difficulty that if this gold were precipitable in the usual way, there would be none left in the ocean, unless it were being redissolved as fast as it was precipitated. The fact, if it be a fact, that the ocean everywhere contains a minute but approximately uniform quantity of gold, is in reality a fairly good proof that this gold is *not* being precipitated. Having regard to the circumstance that very many rock masses have been proved to contain minute quantities of gold, it is, moreover, quite unnecessary to go back to the ocean for a known source of this metal. The evidence that gold does occur in various rocks seems to be tolerably complete, and its presence has been detected not only in sedimentary but also in eruptive rocks. Whatever may be said about sedimentary strata, eruptive rocks cannot well be supposed to have obtained the gold they contain from sea water. In fine, reviewing the facts before us a whole, it seems far more probable that whatever gold is contained in the ocean has been leached out of rocks, than that the rocks have derived their gold from the ocean.

We have so far cleared up two distinct points in our investigation, and are justified in assuming—firstly, that the gold of veins was introduced in solution, and secondly, that its source may probably be traced to various rocks of the earth's crust, and very possibly deep-seated ones, such as eruptive rocks must have been originally. Two other points yet remain: How was the gold dissolved out of the rocks in which it existed? and how was it deposited from such solution? To these latter two queries I fear that our answer will have to be less definite than to the former ones, much of our knowledge, if knowledge it is, being only inferential. If we consider a fissure in the earth's crust, lying below the region of the superficial currents of underground water—the "vadose circulation" of Pošepný—we must in the first place look upon it as necessarily filled with water, and in the second place we must suppose this water to be in motion. The pressure in the fissure will probably be less than in the deeper-lying and adjacent rock-masses, and the greater temperature of the lower parts of the fissure will give rise to convection

* Whilst these pages were passing through the press, I received a copy of the presidential address of Mr. Stanford to the Society of Chemical Industry, delivered in July, in which that gentleman says: "No analysis can give us any idea of what the ocean really contains. . . . The presence of gold has not been satisfactorily proved; it was expected it might accumulate in the copper sheathing of ships, and Messrs. Muntz obliged me with specimens of old sheathing, both copper and Muntz metal. Mr. Inglis, who kindly examined these for me, found both gold and silver, but not in larger proportion than usual."—(*Journ. Soc. Chem. Ind.*, Vol. XIII., No. 7, p. 697). H. L.

currents carrying the lower water to the upper portions of the fissures; other water must descend to take the place of that so driven upwards, and thus a deep circulation will be maintained, aided, no doubt, by inequalities of pressure and capillary action. These water currents would evidently suffice for the conveyance of dissolved gold into the fissures, if we can account chemically for its solution. It must not be forgotten that we have no actual knowledge of the behaviour of substances under such conditions of intense temperature and pressure as prevail in the deeper regions of the earth, and that we are compelled to reason from our laboratory experiments, which may, however, be leading us directly away from the truth. With this proviso, it is not difficult to imagine conditions under which gold may pass into solution. The most permanent soluble salts of gold are the haloid salts, and it has usually been assumed that it is in this form that gold occurs dissolved in Nature. In the paper already referred to, I suggested that it is far more probable that the gold is dissolved in the form of an alkaline aurate. It is well known that fused alkalies, in the presence of air or of an oxidizing agent like nitre, attack gold, forming an aurate soluble in water, and also that many natural waters are strongly alkaline. Perhaps the strongest argument in favour of this view is the invariable association of gold with quartz, an association too invariable to be accidental; so that it seems natural to suppose that the solvent that carried the quartz into the fissure carried the gold also. I personally prefer this explanation, which rests upon reactions and compounds that we know, to imagining a hypothetical soluble silicate of gold that may or may not exist. It presents, moreover, distinct analogies to another mode of solution of gold, of which we have positive evidence—its solution as a sulph-aurate in the two localities already quoted, Steamboat Springs and Sulphur Bank. Both these localities have been repeatedly described by writers on the genesis of mineral deposits; nevertheless, a few lines about them, with reference more particularly to the question we are now considering, may prove of interest. The best account of both is to be found in Becker's monograph on the geology of the quicksilver deposits of the Pacific slope in the *United States Geological Survey*, Vol. XIII. (1888); J. Le Conte has also written on the subject in the *American Journal of Science*, Vols. XXIV. and XXV. Steamboat Springs is the name given to a small district in Washoe County, Nevada, well known as a thermal health resort, some six miles from the Comstock lode. The underlying rock of the district is granite, which is overlaid in many places by metamorphosed rocks of the Jurassic system and by lavas. The springs issue from a series of vents in a narrow valley between two volcanic ridges, the waters being very hot, alkaline, and charged with carbonic acid and sulphuretted hydrogen. Analysis has shown that these waters contain traces of many metals, amongst them gold. The vents out of which the water comes are the remains of a series of extensive fissures, which are now nearly choked up by having been filled with silica deposited by the springs themselves. These deposits are "in many places stained and clouded with metals. . . . In places where there is water still issuing slowly, silica is found in a gelatinous condition. . . . Here then, undoubtedly, mineral veins are now forming under our eyes, but their metallic contents are in very small proportion" (Le Conte, *loc. cit.*). It is noteworthy that cinnabar has been mined in the immediate neighbourhood, and that the deposits of this mineral are evidently closely connected with the springs themselves. The phenomena at Sulphur Bank, California, closely resemble the foregoing. The country rock consists of Neocomian sandstones and a series of metamorphic rocks, intersected by eruptive basalts. There are numerous hot mineral springs carrying alkalies and alkaline sulphides in solution, associated with a series of deposits of cinnabar and silica, crystallized and amorphous. These latter have been mined, and streams of heated water and gases were met with in the course of the operations. The deposits occur both in the sandstones and the basalts. Other sulphides are present besides cinnabar, and these have been shown to contain gold. Most geologists who have studied these deposits are of the opinion that their formation has not yet ceased. Becker thus summarizes his views on both these deposits: "I regard many of the gold veins of California as having an origin entirely similar to that of the quicksilver deposits. . . . The evidence is overwhelming that the cinnabar, pyrite and gold of the quicksilver mines of the Pacific slope reached their present positions in hot solutions of double sulphides, which were leached out from masses underlying the granite or from the granite itself" (*op. cit.*, pp. 449, 450). In both these localities, therefore, gold has been pretty conclusively proved to be in the course of deposition from hot alkaline sulphuretted solutions, in which there is little doubt that the gold is dissolved as a double sulphide of gold and an alkali, or, in other words, as an alkaline sulph-aurate. Apart, therefore, from the doubt thrown at the outset upon any theories based upon our laboratory experience, there seems to be little difficulty in accounting for the solubility of gold at depths far beneath the earth's surface.

The last stage of the process is also the most difficult of explanation. Given that the gold is in solution, we have to account for its deposition in the fissure under circumstances that do not admit of its re-solution in the same water current. Perhaps the wisest course is simply to confess our ignorance whilst suggesting tentatively a few plausible hypotheses. Of course the solution, when it enters the fissure, contains a number of other substances, notably silica, in solution besides the gold, and whatever cause determined the deposition of these substances most probably precipitated the gold also. For all we know, this cause may have been some electrolytic action. Or again, if temperature and pressure are requisite for the retention in solution of the various substances, these latter would naturally be deposited when the solution found its way into the upper parts of the fissure, where the pressure would be lower and the temperature would be gradually decreasing as the solution rose upwards. It is easy to imagine the mixture in the fissure of the original solution with another which might contain dissolved in it various reducing agents. Or, if the fissure already contained particles of various metallic sulphides, these would precipitate gold readily from such a solution as the one described above. I have proved experimentally that natural sulphides, such as galena and iron pyrites, precipitate gold readily from a solution of an alkaline aurate. The simultaneous deposition of such a metallic sulphide and of gold from a sulph-aurate would probably account for the intimate state of combination of gold with various "sulphurets," which, to his sorrow, the primitive gold miner knew but too well, and to extract the precious metal from which, all the resources of modern scientific metallurgy are needed.

Any of the above hypotheses are admissible as possibly correct explanations, though it is hardly safe to say anything more than this in their favour. It is more than probable that no one simple reaction can account for all the various occurrences of gold in veins, and that whilst the above may all be valid hypotheses, there are probably many other causes of precipitation besides those enumerated.

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There is no branch of geology less advanced at the present day than geological chemistry, to which subject this sketch of the genesis of gold reefs properly belongs. At nearly every step we are groping in the dark, with but faint gleams of light from experimental science—the only safe guide we can have—to show us the way that we should attempt to follow. And whilst none can be more sensible than myself of the numerous defects and shortcomings in the theory here presented, I venture to hope that even the mere attempt to put together the different hypotheses on the subject may have its value, were it only in accentuating the extent of our ignorance.

WHAT IS A STAR CLUSTER?

By A. C. RANYARD.

ACCORDING to the generally received nebular hypothesis, our sun and the luminous stars have been formed by the condensation of nebulous masses. Kant, Sir William Herschel, La Place, and the other earlier exponents of the nebular hypothesis who lived before the great principle of the conservation of energy had been propounded, assumed that the nebular masses must, when originally distributed in space, have been intensely heated to a far higher temperature than the luminous stars which were evolved from them.

The great difficulty of conceiving of a hot nucleus remaining after ages of radiation into space from the vast surface of a nebular mass does not seem to have occurred to these earlier theorists, or, if it occurred to them, the difficulty was swept on one side by assuming a still higher temperature for the parent nebulous mass. But when the mechanical equivalence of heat with other forms of energy was demonstrated, it became evident that the heat of the condensed nucleus might be derived from the motion of the nebulous particles colliding with one another during condensation. Thus a method of accounting for the great heat and light of the stars was offered, and the popularity of the nebular hypothesis was greatly enhanced.

It seemed reasonable to suppose that we should find large and small nebulous masses in all stages of condensation. The large and irregular nebulæ were pointed to as nebulous masses which were in the earliest stages of condensation. Nebulous stars were supposed to be in an intermediate stage, and ordinary stars were in a still later stage, approaching a condition in which they would cease to shine as incandescent bodies. But if the ordinary assumptions of the nebular hypothesis were true, the earlier stages of condensation would occupy a much longer period than the final stages, and we might expect to find a much greater number of oblate nebulous spheroids (such as the hypothesis of La Place assumes) than of stars in the later stages of condensation before their incandescent condition had passed away. It could hardly be urged that the stars and nebulous condensing masses were all so far removed from us that they all equally appeared as stellar points of light; for incandescent spherical masses, comparable in diameter with the orbit of Neptune, or even with the orbits of Saturn or Jupiter, would in our larger telescopes present very recognizable discs if they were situated at distances from us ten or fifteen times as great as the space which separates us from our nearest stellar neighbours.

While there are millions on millions of stellar points of light to be observed in the heavens, the number of spherical nebulous masses revealed by the telescope is comparatively few, a fact which may be reconciled with the nebular hypothesis by assuming that the condensing masses only commence to be incandescent when they have shrunk to diameters of a few million miles, and that in the earlier stages of incandescence the nebulous matter is cold and dark, or only glows at a faint red heat, which is not sufficiently bright to render the nebulous mass visible at a distance.

There are also a few nebulous rings and spirals which shine with a faint nebulosity in the heavens, and a great many nebulæ of very irregular form generally surrounding stars or associated with groups of stars, in a manner which would seem to indicate that the nebulous matter had issued from the stars rather than that it is condensing about them, for frequently there are arms of nebulosity or nebulous structures which appear to spring from the place occupied by a star or group of stars within the nebula. Such nebulæ would seem to present a closer analogy with the solar corona than with the fiery condensing mists conceived of by La Place.

The form of the coronal structures about our sun indicates that the coronal matter has issued from the sun, and though we may, no doubt, assume that the matter which is shot forth from the sun, as a general rule, returns to it again, the brighter structures of the corona seem to indicate by their form that they are composed of matter on its outward course, that is, in its hot condition, as it is shot upward from the sun. There are no coronal structures the form of which indicates a downward flow of matter, and it seems, therefore, reasonable to assume either that the coronal matter returns to the sun as a uniform mist or that it returns in a comparatively non-luminous form.

There seems to be a very close analogy between the irregular nebulæ and star clusters. Recent photographs indicate that most star clusters are nebulous, or contain whisps of faint nebulosity, and the irregular nebulæ are all associated with groups or clusters of stars. Irregular nebulæ, as well as star clusters, are distributed along the region of the Milky Way, and seem in some way to be associated with it, while the smaller and regular nebulæ have a tendency to cluster in the poles of the Milky Way.

If the nebulous matter of the large and irregular nebulæ has been shot forth from stars, it seems to follow that the nebulous matter of star clusters has had its origin in the stars of the cluster rather than that the stars of the cluster have condensed from the nebulous matter.

Prof. George Darwin pointed out some four or five years ago that if two solid bodies were to collide with planetary velocities, such a rapid evolution of gas would take place, by reason of the heat developed at the region of contact, that the bodies would rebound from one another almost as if they were perfectly elastic bodies. If the moving bodies were liquid or gaseous, no doubt a similar evolution of heat at the region of contact would take place, causing an elastic rebound, and it seems not improbable that within a short period after such a collision the gaseous matter evolved at the region of contact would be distributed in space between the rebounding bodies, forming as it were a nebulous ligature between them; but it seems difficult to account on this theory for a line of stars joined by nebulosity such as we find in the Pleiades, or for a series of stars in a curving line ligatured together by a band of nebulosity. Such curving prominence-like forms as are shown in Fig. 1, or the branching form shown in Fig. 5, seem rather to indicate that the matter which is now luminous has been shot out as a gaseous stream, and that the luminous matter has subsequently aggregated into luminous masses.

The very beautiful pictures of the Hercules cluster which

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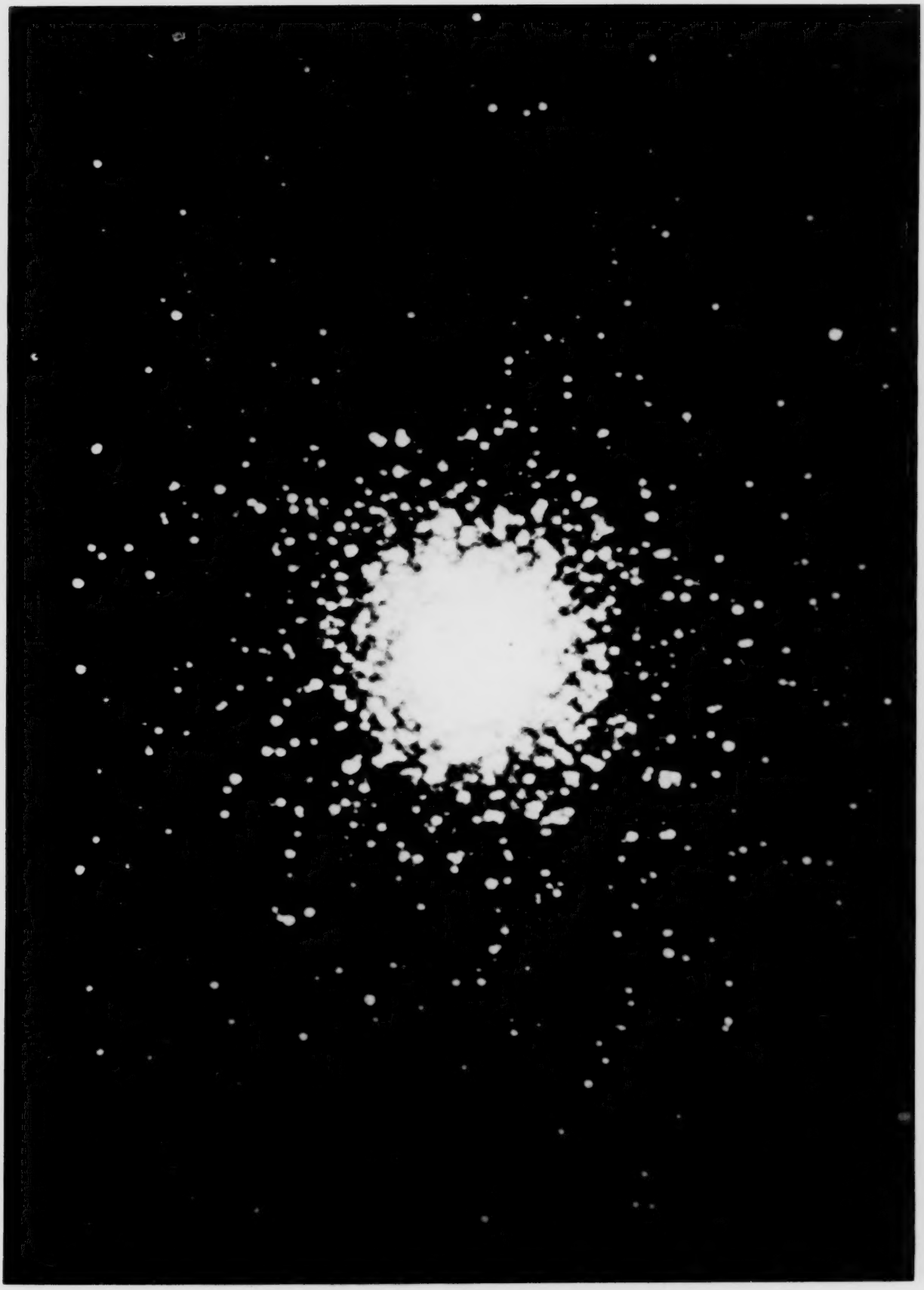

THE CLUSTER IN HERCULES (MESSIER 13).

Enlarged from a Photograph taken by Mr. W. E. Wilson, of Daromona, Co. Westmeath, Ireland, with a silver-on-glass reflector by Sir H. Grubb, of twenty-four inches aperture, and ten feet six inches focal length. Photograph taken August 5th, 1894. Exposure, one hour.

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THE CLUSTER IN HERCULES (MESSIER 13).

From a Photograph taken by Mr. W. E. WILSON, of Daromona, Co. Westmeath, Ireland, with a reflector of two feet aperture, and focal length of ten feet six inches. Exposure, one hour.

Direct Photo Engraving Co., 9, Farringdon Park, E.

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From a Photograph taken by Mr. W. E. WILSON, of Daromona, Co. Westmeath, Ireland, with a reflector of two feet aperture, and focal length of ten feet six inches.
Exposure, one hour.

Direct Photo Engraving Co., 9 Roseberry Park, N.

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illustrate this paper have been reproduced from photographs given me by Mr. W. E. Wilson, of Daromona.

The light-grasping power of Mr. Wilson's instrument is so great that, with only an hour's exposure, smaller stars and a considerably larger area of nebulosity have left their imprint upon the photographic plate than are to be traced upon the photographs made at the Lick and Paris observatories with exposures three times as long. Therefore, in comparing these photographs of the Hercules cluster with the photographs published in the June number of KNOWLEDGE for 1893, the reader must bear in mind that the structures and star-streams which appear to project from the edge of the spherical cluster in the Lick and Paris photographs are in Mr. Wilson's photographs to be found imbedded in nebulosity at some distance below the boundary where individual stars become separately visible.

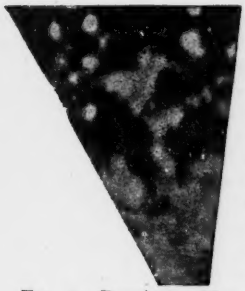

FIG. 1.—Prominence-like Structure, from photograph by the Brothers Henry.

This will be more clearly recognized if we take an example; thus, the prominence-like structure shown in Fig. 1, which in the Henry photograph projects from the upper part of the nebulous mass, will be found in the Wilson photographs imbedded in nebulosity. The scale on which the Wilson photograph is here reproduced is smaller than that of Fig. 1, so that the prominence-like structure about corresponds with the scale of Fig. 4. This structure, as seen in Mr. Wilson's photographs, is somewhat interfered with by a dark bar or lane extending horizontally across the page. It is one of the three dark lanes, diverging from a point, which were first noted by the Earl of Rosse, and have been described by Webb and several observers since his day. These diverging dark lanes are pretty obvious when the cluster is observed in a large telescope. It will be noticed that the outer lane (which is nearly radial with the centre of the cluster) is much the most marked of the three, as shown in Mr. Wilson's photographs, and that there are some small, branching, dark structures which diverge from it on either hand. Mr. Wilson's photographs also show several other small dark areas within the cluster, which should be compared with the dark areas within the ω Centauri cluster, a photograph of which is reproduced in KNOWLEDGE for May, 1893. But one of the most interesting features in Mr. Wilson's photographs is that many of the stars in the outer parts of the cluster are distinctly seen upon the photographs to be united by ligatures of nebulosity. It has been very difficult to reproduce these nebulous ligatures in the etched blocks or in the collotype plate. They are, perhaps, most marked and easily recognizable in the upper right hand quadrant (see Fig. 3). But there is no doubt about their existence, and in the silver prints and platinotype prints made from Mr. Wilson's original enlargements they are very clearly shown. Mr. Wilson himself has no doubt as to their actual existence; that is, he believes that they are not due to any optical or photographic defect.

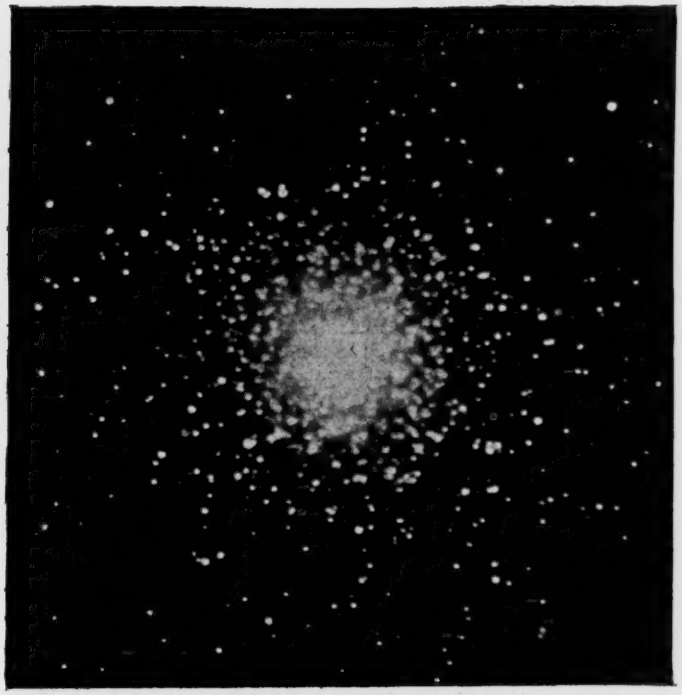

FIG. 3.—Untouched etched block made from a photograph of the Hercules Cluster taken by Mr. W. E. Wilson on the 5th August, 1894.

FIG. 4.—Prominence-like Structure. Reproduced from the Henry photograph.

FIG. 2.—Untouched etched block made from a photograph of the Cluster in Hercules taken by the Brothers Henry on the 23rd June, 1886.

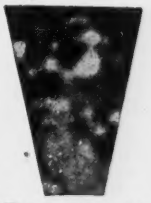

FIG. 5.—Branching Structure, from photograph by the Brothers Henry.

It will be remembered that in the enlargements from the Henry photographs similar nebulous ligatures between stars were observable, joining them up into branching streams radiating outwards from the central regions of the cluster. We therefore appear to have corroborative evidence in these photographs by Mr. Wilson, proving that in both the inner and outer parts of the cluster the stars are physically connected with one another in streams which seem to be radially arranged with respect to the centre of the cluster, and that these streams of stars linked together by nebulosity are intimately associated with streams or patches of the light-absorbing material which gives rise to the dark lanes or patches.

PHOTOGRAPHS OF RORDAME'S COMET.

THE photograph of Rordame's comet, published in the July number of KNOWLEDGE, is referred to as having been sent to me by Mr. J. N. Cobb, of Philadelphia, who obtained it from Mr. Alfred Rordame, of Salt Lake City, Utah. I have since learned, by letters received from Mr. Rordame as well as from Mr. Cobb, that the photograph was taken by Prof. W. J. Hussey, when on a visit to Mount Hamilton, with the Crocker telescope of the Lick Observatory. Prof. Hussey has also kindly sent me glass transparencies of five other photographs of Rordame's comet, making in all six photographs, obtained by Prof. Hussey on the 12th, 13th, 14th, 15th, 16th and 18th of July, 1893. I have reproduced three of the glass transparencies on the accompanying plate. The photograph taken on the 13th was reproduced in the July number, and those taken on the 15th and 16th have arrived in a scratched condition, which makes them unsuitable for reproduction, but they form a most interesting series, illustrating the great rapidity with which the tails of small comets vary in form from day to day. For the purposes of reproduction silver prints or platinotypes from the original negatives are generally preferable to copies on glass, which are very apt to get injured. The streamers of the tail appear to issue from the centre of the nucleus, and not from either side of the envelopes about the comet's head, as the drawings of some of the larger comets would lead one to suppose, but this may possibly be due to photographic irradiation, which causes the bright nucleus and surrounding envelopes of the comet's head to appear on the photographs larger than they really are.

Notices of Books.

Celestial Objects for Common Telescopes. Vol. II. Fifth Edition; revised and greatly enlarged by the Rev. T. E. Espin, M.A., F.R.A.S. (Longmans, Green & Co., 1894.) The re-editing and bringing up to date of this valuable book must have been a very difficult task, but Mr. Espin has accomplished it with great tact and discretion, leaving sufficient of the original matter unaltered to preserve the charm of Prebendary Webb's style, and yet adding sufficiently to the text and in foot-notes to bring the work abreast with the time. The earlier editions of "Celestial Objects" appeared when comparatively little had been done in stellar spectroscopy, and Mr. Webb had modestly decided not to attempt to enter upon the subject, as being too difficult for himself and his readers; but this subject has now become such an important department of modern astronomy, and so many more amateurs now make use of spectroscopes, that spectroscopy could no longer be ignored. Few better men than Mr. Espin could have been found to bring up to date the stellar chapters of Mr. Webb's classical handbook, and he has evidently worked at it as a labour of love. The second volume, which now appears, contains only the chapters referring to stars, clusters and nebulæ. The division of the book into two volumes is necessitated by its increased bulk due to the growth of observational astronomy, and the division is convenient, for this portion of the book is the part which will be most required for use in the observatory, while the first volume may be kept for indoor use. The descriptions of celestial objects are now arranged in order of their right ascension in each constellation, thereby saving the fifty pages of Appendix II. in the fourth edition.

A Treatise on Astronomical Spectroscopy, being a translation of "Die Spectralanalyse der Gestirne." By Prof. Dr. J. Scheiner. Translated, revised, and enlarged by Edwin Brant Frost, M.A., Assistant Professor of Astronomy in Dartmouth College. (Ginn & Co., Boston and London, 1894.) The thanks of astronomers are due to Prof. Frost for the labour he has bestowed upon this English edition of Prof. Scheiner's book. In many parts of the work he very closely follows Prof. Scheiner, but in others he has needed to expand the text considerably in bringing the work up to date. An interesting fact, indicating the relative compactness of the English and German languages, may be noted, where Prof. Frost has most closely followed Scheiner's original; the English saves one page in about every ten of the German. The book will be welcomed by all English-reading spectroscopic observers.

The following books have been received for notice:—

Practical Work in General Physics. By W. G. Woollcombe, M.A., B.Sc. (Clarendon Press.)

Fifth Annual Report of the Missouri Botanical Garden. (St. Louis, Mo.)

The Stereoscope and Stereoscopic Photography. From the French of F. Drouin. (Percy Lund & Co.)

Letters.

[The Editor does not hold himself responsible for the opinions or statements of correspondents.]

A PROLONGED SUNSPOT MINIMUM.

To the Editor of KNOWLEDGE.

DEAR SIR,—The partial suspension of solar activity, established by Mr. Maunder in his article entitled as above (KNOWLEDGE, August, 1894), represents a curious phase of solar history. There is, besides, strong, although indirect evidence that the "prolonged sunspot minimum" was attended by a profound magnetic calm. This evidence is to be found in the auroral records of the time. For the connection between the occurrence of auroræ and the magnetic condition of the earth is so close, that the absence of one kind of disturbance may safely be held to betoken the absence of the other.

Now in England, during the whole of the seventeenth century, not an auroral glimmer was chronicled. Stowe recounts that on the 14th and 15th of November, 1574, "the heavens from all parts did seem to burn marvellous ragingly"; * and the next similar occurrence took place on March 17th, 1716. Upon his observations of this fine display, Halley founded his magnetic theory of auroræ.† The event created an extraordinary sensation throughout the country, some slight and partial sky-illuminations in 1706 and 1709 having escaped general notice.

* *Annales of England*, p. 678.

† *Philosophical Transactions*, Vol. XXIX., p. 407. See also E. J. Lowe's "Chronology of the Seasons," quoted by Dr. Garnett in *Nature*, Vol. III., p. 46. For a fuller account of auroral history during this period we may refer to the *Edinburgh Review*, No. 336 (October, 1886), pp. 418-421.

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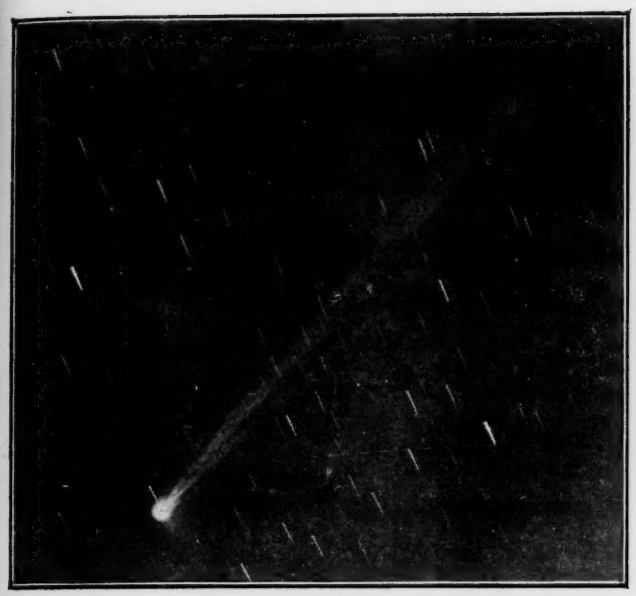
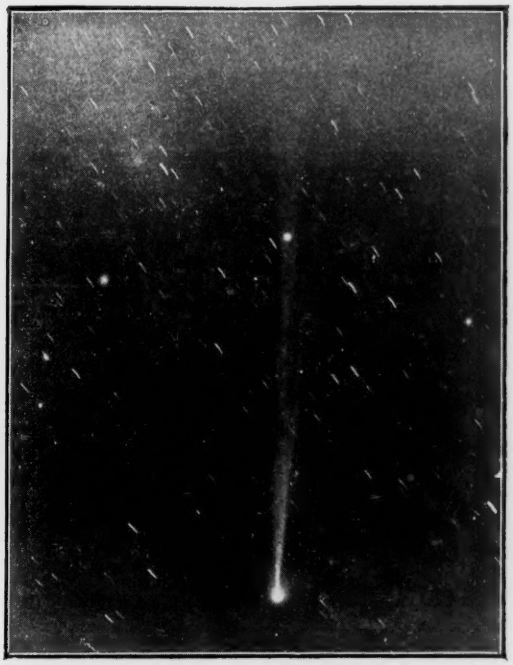


1893, July 12th, 9h. 0m. to 10h. 12m., Pacific Standard Time.



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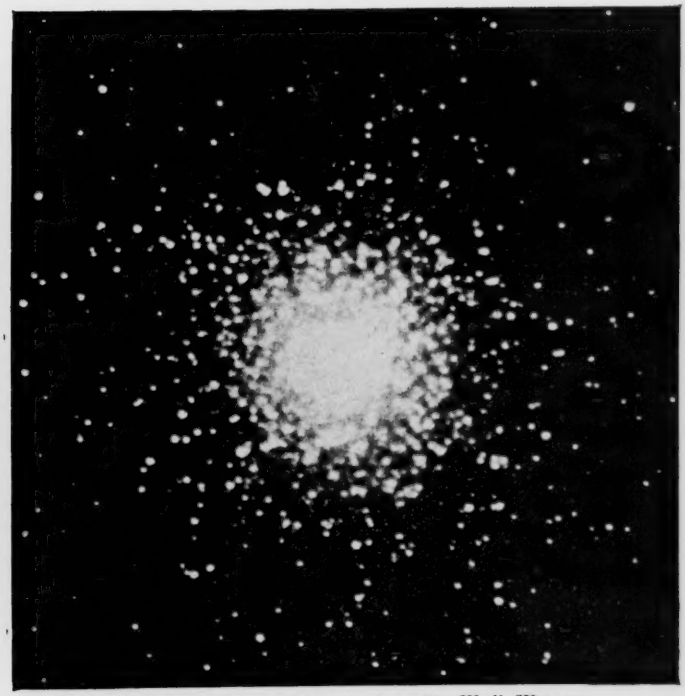
1893, July 14th, 9h. 8m. to 10h. 28m., Pacific Standard Time.



(13 Messier). From a Photograph by Mr. W. E. Wilson.

COMET b 1893 (RORDAME).

From Photographs taken by Prof. W. J. Hussey with the Crocker Telescope at the Lick Observatory.

Direct Photo Engraving Co., 9, Barnsbury Park, N.

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On the Continent, the auroral blank was much less complete than in this country. Gassendi's aurora of September 12th, 1621, was seen as far south as Aleppo; Cromerus registered the passage of "whole armies" across the sky in 1629; in 1640, south polar lights were visible in Chili every night of February and March, and some corresponding appearances were noted in northern latitudes. By the middle of the century, however, polar lights had virtually died out everywhere, except perhaps in northern Scotland, where the "merry dancers" were seen without surprise in 1691. But even in Iceland and Norway they became so rare as to be considered portentous, and their reappearance at Copenhagen in 1709 was greeted with consternation and amazement. De Mairan, in his "Traité de l'Aurore Boréale," makes the curious remark that a great extension of the zodiacal light attended the auroral outburst of 1716.

As regards the solar corona during the "prolonged minimum," it appears probable that (as Mr. Maunder suggests) its radiated structure was in abeyance, but there is positive proof that the inner corona maintained at least its average brightness in 1666. The partial solar eclipse of June 22nd in that year, being viewed through Boyle's sixty-foot telescope by Hooke, Pope (Professor of Astronomy in Gresham College), and others, "there was perceived a little of the limb of the moon without the disc of the sun, which seemed to some of the observers to come from some shining atmosphere about the body either of the sun or moon."*

Yours faithfully,
AGNES M. CLERKE.

THE PROGRESS OF ASTRONOMICAL PHOTOGRAPHY, by H. C. RUSSELL, F.R.S., Government Astronomer, Sydney.

To the Editor of KNOWLEDGE.

DEAR SIR,—Mr. Russell chose wisely the subject of his recent presidential address before the Mathematical Section of the Australasian Association for the Advancement of Science. With what authority he is entitled to speak upon it, your readers can judge for themselves from the specimens of his photographs reproduced in KNOWLEDGE. The delineations obtained by him of the Magellanic clouds and of the Coal-sack region of the Milky Way have, indeed, a significance which is as yet very far from being exhausted. The story that he now recounts is a marvellous one. "The results," he truly says, "obtained by means of photography come upon us so fast that one hardly realizes their importance." The method has developed in so many different directions, and lent itself so readily to specialization, that their history, short though it be in time, has already assumed an exceedingly complex character. Mr. Russell has adopted a strictly chronological mode of treating it, and has brought together in small compass a large amount of valuable information; but with some startling omissions. Thus, Prof. Barnard's name is not so much as mentioned. Yet the fame of his achievements in this department is world-wide. We need only recall his initiation of galactic photography in 1889, and his subsequent successful prosecution of it; his registration, from night to night, of changes in comets' tails, his discovery on a sensitive plate, in 1892, of an additional member of Jupiter's cometary family, besides his exquisite picture of the solar corona of January 1st, 1889. Dr. Max Wolf and M. von Gothard, each of whom has done important and distinctive work in celestial photography, incur similar oblivion; but they may take heart when they find Dr. Gill no better treated. It seems incredible that a man who is the very head and front of photographic star-charting should be passed over in such a record as Mr. Russell's; but such is the fact. Not only was the star-crowded background of his portrait of the "great September comet" of 1882 the object lesson from which astronomers learned its possibility, but he was foremost in starting and developing in detail the international scheme now in course of execution at a score of observatories. Above all, he set the example of *doing*, by completing Argelander's *Durchmusterung* to the southern pole. The resulting catalogue—the first photographic work of its kind—gives the places, accurate to within about one second of arc, of some 350,000 stars. It is at present rapidly passing through the press. Nor should it be forgotten that Prof. Kapteyn generously devoted five years to the labour of its preparation from the Cape plates.

We look in vain, too, in this address, for any allusion to Nova Aurigæ, the first "blaze-star" investigated photographically, or Nova Normæ, the first similar object discovered photographically. Indeed, none of Mrs. Fleming's valuable detections are chronicled. Nor do we find the slightest reference to the self-registration of new asteroids or of meteors, although researches of the latter kind seem about to enter upon a fresh stadium of progress through the possibility, just demonstrated by Dr. Elkin, of determining the radiants of meteoric showers from the imprinted trails of their constituents.† Mr. Russell, however, eagerly anticipates novelties, and is full of well-grounded confidence in the future. He himself promises a photographic transit recorder, and indicates several lines of imminent advance. Obstacles there are, but only to be overcome. "The army of science," he continues, "is in one respect like the army of war—it is stirred to conquering effort by the difficulties that stand in the way. Given a citadel to be won, and there is always a forlorn hope to win it." These words breathe the true spirit of a scientific pioneer.

Yours faithfully,
A. M. CLERKE.

To the Editor of KNOWLEDGE.

DEAR SIR,—The Rev. A. S. Wilson, in an article on "Types of Floral Structure" which appears in the July issue of KNOWLEDGE, says "there is no apparent reason why the carpels and stamens should not occasionally change places, and an explanation of this invariable order is still a *desideratum*."

A sufficiently obvious reason, it seems to me, is found in the fact that the stamens of the flower are not persistent. As soon as their pollen is shed, their work is done, they become useless and decay, or fall off. If they occupied the centre of the flower they would be prevented from so doing by the carpels, which persist long after the stamens have decayed, and in the case of syncarpous pistils there would be a central cavity in the fruit enclosing the dead stamens.

Besides this, if the stamens were central it would be easy for their pollen to become dusted on to the adjacent stigmas, an arrangement which Nature has, in the great majority of cases, endeavoured to avoid.

Yours faithfully,
GEO. H. PETHYBRIDGE, B.Sc.

Kingswood School,
Bath,
August 14th, 1894.

* *Philosophical Transactions*, Vol. I., p. 295.

† Dr. Elkin's success is too recent to have been known to Mr. Russell when his address was delivered.

THE PERIODICITY OF THE SOLAR SPOTS, AND ITS CAUSE.

To the Editor of KNOWLEDGE.

SIR,—In his exceedingly interesting article, "A Prolonged Sunspot Minimum," in the August number of KNOWLEDGE, Mr. Maunder mentions that the cause of the periodicity of the solar spots has been ascribed to the periodical returns of the planet Jupiter to the perihelion of its orbit, but significantly adds that if this were the true cause, "since that return is regular, punctual, and unfailing, so ought its effect to be, and it should be as impossible for the sun to intermit two or three of its cycles as for Jupiter to wander from his orbit." To me the theory in question never had much to recommend it; not only is the eccentricity of Jupiter's orbit very small—less than that of Saturn, and considerably less than that of Mars—but his period (11·9 years) is much longer than that of the average period of the solar spots. The facts about the latter which are adduced by Mr. Maunder are surely sufficient to negative any connection between the periodicity of the spots and the regularity which characterizes planetary motions, disturbed only by perturbations which cannot affect such a question as this.

Some little time ago, I suggested in *The Observatory* that the recurring maxima and minima of solar spots might be due to a swarm of meteoric bodies which move in an eccentric orbit, and pass, when in perihelion, near the outer envelope of the sun. Although the period suggested by Schwabe for the solar spots was 10·4 years, it is now well understood that the true average period amounts to 11·1 years. Now a body or bodies revolving round the sun with this period would have a mean distance from him of 4·98 in terms of the earth's mean distance; and if the perihelion distance were small, the aphelion would not differ much from that of Saturn. *L'Astronomie* did me the honour to refer to my suggestion, but pointed out that the details of explanation and of the action of the meteors were wanting. Now time may supply what is certainly beyond my power at present; but it seems to me that if the theory be true, one remarkable detail in connection with it is suggested by this article of Mr. Maunder. "The sequence," he justly remarks, "of maximum and minimum has been unfailing during the present century." He then goes on to dwell on his main point, that not only this cannot be affirmed of the phenomena during preceding centuries, but the observations recorded, though not made of course with Greenwich regularity and perseverance, are abundantly sufficient to prove that the matter was then far otherwise; and particularly that during the fifty years which elapsed from 1655, or thereabouts, to 1705, very few solar spots were seen, or, as he puts it, "an extraordinarily and immensely prolonged minimum" subsisted. But what if regular maxima and minima had not then begun to be, and the spots seen previously were of a more sporadic kind? Le Verrier thought that the Leonid meteors were introduced into our system by the attraction of Uranus about the second century after Christ. Perhaps the swarm of meteors to which I suggested we owe the present regular recurrence of the spots may have been introduced by the attraction of Saturn in the early part of the eighteenth century.

Yours faithfully,
Blackheath, August 10th, 1894. W. T. LYNN.

[I would refer Mr. Lynn to Prof. Rudolf Wolf's paper on "Sunspot Maxima," published in the *Memoirs of the Royal Astronomical Society*, Vol. XLIII. Unless he is prepared to reject Prof. Wolf's laboriously collected evidence, he must admit that there have been wide variations in the form of successive waves of the sunspot curve, even during this century; thus Wolf gives a sunspot maximum in 1804, another in 1816, followed by another which was deferred till 1830, while the next maximum period followed in 1836-7, giving intervals of twelve, fourteen and six and a half years. Such tidal action as Mr. Lynn suggests would, if caused by a single flight of disturbing bodies, necessarily be regular.—A. C. RANYARD.]

ANTARCTIC BIRDS.

By WILLIAM S. BRUCE, *Naturalist to the Antarctic Expedition*, 1892-93.

THE term "Antarctic regions" is vague, and it is necessary to define to our readers the limits of this region about which we have such scanty records. The Antarctic Ocean proper is that portion of the great oceanic area of our globe which lies within the Antarctic circle, or south of the latitude of 66½° S. In dealing with the Antarctic, however, few, if any, writers confine themselves to this area. Many include regions as far north as Patagonia, Falkland Islands, south of South Africa, south of Australia, and the south of New Zealand, while others vary their limitations of the Antarctic by various localities lying between these northern and southern limits. In this article it is proposed to call those birds Antarctic birds which are to be found in higher southern latitudes than the extreme limit of floating ice according to the most recent research. The northern boundary of these regions is somewhat irregular, but roughly may be said to extend as far north as 40° S., *i.e.*, a latitude corresponding to that of Madrid and New York in the Northern Hemisphere. This excludes Tristan d'Achuna, South Africa, and Australia—which lie north of 40° S.—Tasmania, New Zealand and Auckland Islands, South America and the Falkland Islands, and Kerguelen Island; for although these last-named are in latitudes south of 40° S., yet the ice line rises southward in their respective longitudes. Three exceptions are made to this boundary, viz., the Tristan d'Achuna group, Kerguelen, and the Auckland Islands, which have always been associated so intimately with Antarctic exploration. In this way we exclude the great continental masses, save Antarctica itself, but include almost all those islands which most writers term Antarctic islands.

With few exceptions, the birds of the Antarctic are all oceanic species, the penguins and the petrels being by far the most important groups. Besides these, there are also gulls, terns, and the remarkable sheathbills or paddies. Let us first consider the penguins, which are perhaps the most typical of all Antarctic birds, although they may also be found as far north as the Galapagos group of islands, which lie almost upon the equator, off the west coast of South America.

A very interesting and graphic description of these remarkable birds has been given by the late Prof. Moseley.* Whilst the "Challenger" was in the vicinity of the Tristan d'Achuna group, he says, "as we approached the shore I was astonished at seeing a shoal of what looked like extremely active, very small porpoises or dolphins. I could not imagine what the things could be unless they were indeed some most marvellously small cetaceans; they showed black above and white beneath, and came along in a shoal of fifty or more from seawards towards shore at a rapid pace, by a series of successive

* "Notes by a Naturalist on H.M.S. Challenger," by Moseley: J. Murray, London.

leaps out of the water and splashes into it again, describing short curves in the air, taking headers out of the water and headers into the water again; splash, splash, went this marvellous shoal of animals, till they went splash through the surf on to the black stony beach, and there struggled and jumped up amongst the boulders and revealed themselves as wet and dripping penguins, for such they were. Much as I have read about penguins, I never could have believed that the creatures I saw thus progressing through the water were birds, unless I had seen them to my astonishment thus make the shore."

The first I saw of these birds was off the shores of the Falkland Islands, over two hundred miles from the nearest land. The vessel was making little headway through the water, the wind having fallen, and coming on deck for midday observations my attention was called to "some small seals," which were playing about the stern of the vessel. They were swimming calmly about in the water, now immersing themselves entirely, now lifting their heads only above water much in the same way as one sees seals doing in the evening, or on a bleak day, when they prefer to remain in the water rather than to come out and lie on the ice, as they do when the sun shines brightly. What the sailors took for seals were really macaroni penguins (*E. chrysolophus*), with their silky, hair-like feathers looking like wet fur. The sailors refuse to recognize feathers in this close-fitting fleece, black on the back, and white on the breast. These are the two ways in which penguins make headway through the water. The reader has only to go at feeding time to the diving birds' house at the Zoological Society's Gardens, in Regent's Park, in order to see the penguins disport themselves. On the land, or on snow and ice, they also have two or three modes of progression; one is when they are standing in an upright position—in this way they may be seen wobbling over the ground with their very short legs and padded feet. When they are in danger, however, they throw themselves upon their white breasts, and use their fore limbs as legs as well as their hind limbs. "When crawling," Darwin says, "it may be said on four legs, through the tussocks or on the side of a grassy cliff, it moves so very quickly that it might easily be mistaken for a quadruped." On the ice they move even more swiftly, as they take advantage of any slope, and glide swiftly down it, toboggan fashion, upon their breasts. In this way, if they choose, they can easily, and sometimes do, escape their captors upon the ice floes; for a man may sink knee-deep into the snow while they glide onward upon its surface. But they are inquisitive, and, fearing no danger, approach their pursuers, only too often to be felled with a club or stick; this is especially the case with the smaller birds. It is to be hoped that penguins will not share the fate of their near relative, the great auk, which at one time was plentiful in the northern seas, but is now a thing of the past.

Rock hopper penguins, which abound in the Tristan d'Achuna group, and which swim in the manner of porpoises or dolphins, "hop from rock to rock with both feet placed together, scarcely ever missing their footing." This method of getting over the ground is also adopted by the king penguin whilst hatching its egg; for it carries its egg from place to place in a pouch, holding it in with its broad webbed feet.

Penguins are gregarious, literally herding together in millions. Sometimes their breeding places, or rookeries, as they are generally called, cover many acres of ground. Some have their rookeries among tussock grass, where there are many streets and side streets occupied by myriads of birds; their dung is a rich manure for the grass, which grows luxuriantly from four to six feet high in clumps, with hard woody masses at their base formed of the old roots and stems, and arches over the streets. Anyone entering these streets is unmercifully pecked at by the birds; their cries are terrific, and the odour arising from their dung is stifling; eventually one flees headlong, tramping on birds and eggs at every footstep. Some breed on the open and bare rock, others, such as the gentoo, build in holes they have burrowed in the ground; and others again, such as the small penguin of New Zealand (*E. minor*) nest in caves. At the entrance to rookeries the rocks are often smooth and polished, which is probably due to the diatoms in the food and dung of the birds, which clings to their feet. The king penguin builds no nest at all. The jackass penguin of South Africa builds its nest of stones, shells, wood, nails, bits of rope, &c., evidently for drainage purposes, although, as Moseley suggested, this may be due to "a sort of magpie delight in curiosities." The magellanic, or jackass penguin of the Falkland Islands, similarly collects variously coloured pebbles at the mouth of its burrows. Most penguin's eggs are greenish-white; that of the king penguin is more than ordinarily pointed at the thin end. As yet we know nothing of the breeding habits, nest, or eggs of the emperor penguin.

It is unnecessary to enumerate and describe all the different species of penguins here; but it may be mentioned that the following four genera are usually recognized, viz., Aptenodytes, Eudyptes, Sphenisci, and Pygosceles. About fifty specimens of about sixteen different species of these four genera are exhibited in the British Museum, South Kensington, and it is well worth while for the reader to pay a visit to the museum to see these most remarkable birds. As in most museums, however, these birds are not as well stuffed as they might be, and it may here be mentioned that one scarcely ever sees a trustworthy picture of a penguin. A penguin in good condition is very plump, and does not go about with an elongated neck, although it is capable of extending its neck considerably. One can never tire of watching these most extraordinary and interesting creatures, they look so human! Often one cannot help laughing outright at the attitudes they assume.

The largest and rarest of penguins is the emperor penguin, which, along with the king penguin, belongs to the Aptenodytes. We must stop specially to consider this bird. The emperor penguin (*A. forsteri*) was first discovered by Captain Cook, and was met with again by Sir James Ross during his ever famous voyage to the South Seas in 1839–43. It was next seen and captured by the Antarctic Expedition, 1892-93. Some fine specimens of the bird may be seen in the British Museum. The largest Ross obtained weighed seventy-eight pounds. "Its principal food," says Ross, "consists of various species of cancri, and other crustaceous animals; and in its stomach we frequently found from two to ten pounds' weight of pebbles. . . . It was a very difficult matter to kill them, and a most cruel operation until we resorted to hydrocyanic (prussic) acid, of which a tablespoonful effectually accomplished the purpose in less than a minute." The largest specimen we obtained weighed seventy-four pounds. The measurements of the dead bird were as follows:—

Length (from tip of beak to vent)	3 ft. 8 in.
Breast girth	29 inches.
Abdominal girth	34 inches.
Muscles of breast (equal to more than one-third total weight of bird, viz.)	25 lbs.

I had hoped to bring this splendid bird home alive, but accommodation on board the vessel did not allow me to

attempt it. It is now to be seen stuffed at the Museum of Science and Art, Edinburgh. I shall presently describe the great strength of this bird.

Among other characteristics, penguins are distinguished by having the bones of the fore-arm flattened, and by a very broad shoulder-blade. The wing feathers are very short and are not differentiated into quills. The young are hatched in a helpless condition. In many respects they resemble, and they are probably related to, the puffins and the auks of the Arctic Ocean.

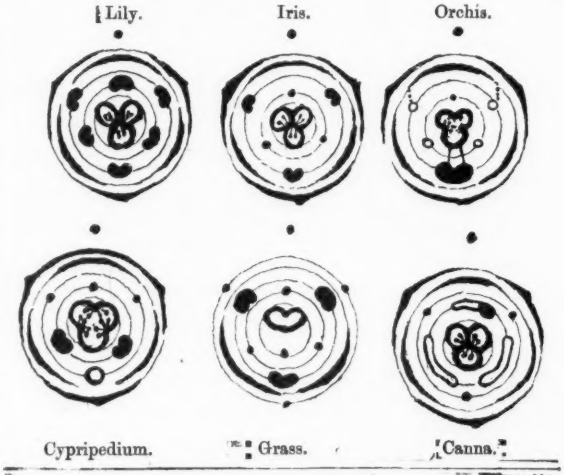
Although penguins are quite unable to fly, one must not look upon their fore limbs as feeble and useless members. They are indeed highly specialized for swimming and crawling, and occasionally also they are used as powerful weapons of defence, as anyone who has seen the effects of a blow which an emperor penguin can give will easily recognize. During the recent expedition, as already stated, we succeeded in capturing and bringing on board alive a very fine emperor penguin; he stood on deck, clothed in silken robes of white and black, decked with gold and purple, a very monarch among his many admirers. An almost full-grown retriever pup that belonged to one of the seamen disapproved of his presence and pounced upon him from behind; the bird seemed to deem his assailant of little importance, as he only turned his head round and drove the dog off with his beak. A second time the dog approached the penguin at his side, and with such force did the bird strike the dog on its head with his flipper, that he sent it away howling with its tail between its legs. It was with the utmost difficulty that five of us secured this penguin, on account of its great strength; it required a man to each leg, a man to each flipper, and a man to his head and neck in order to hold him down. He even broke loose after being strongly bound. The muscles of its breast weighed more than one-third the total weight of the bird, and all this mass of muscle is used to force the wing downwards and forwards. If the reader will look at the keel of the breast-bone of the emperor penguin in the British Museum, he will find that it does not compare meanly with that of the golden eagle and the swan, both powerful birds of flight, while its coracoids are very much more strongly developed. Now this keel serves for the attachment of the muscles of the breast, and is, therefore, an indicator of the relative strength of the fore limbs of different kinds of birds. Although all penguins are not as large as the emperor penguin, they are all equally powerful in proportion to their size. I have seen the smaller kinds jump out of the water on to a cake of pack ice, the surface of which was fully three feet above the surface of the water. Curiously enough, they do not take the advantage of distance, but approach quite close and rise almost vertically out of the water, neatly settling on their hind limbs in an erect position. This is accomplished by the propelling power of their fore limbs.

TYPES OF FLORAL STRUCTURE.—II.

By the REV. ALEX. S. WILSON, M.A., B.Sc.

(*Continued from page* 164.)

THE natural order to which a flower belongs can sometimes be approximately ascertained from the number and position of its parts alone; thus, if we find a specimen with five petals and five stamens placed opposite them we need have almost no hesitation in concluding that it belongs to Primulaceæ. The sea-pink is almost the only native flower outside the primrose order, at all common, which possesses a pentamerous corolla and antipetalous stamens. The order Cruciferæ is easily known; its flowers have a four-petaled, cruciform corolla and six stamens, two of the latter being shorter than the others. Compositæ, Labiatæ, Umbelliferæ, and a few other orders may likewise be recognized by head-mark. To determine the systematic position of a flower, a number of characters must, however, as a rule, be taken into account. We require to know what whorls are present, of how many parts each is composed, and whether the whorls are alternate or superposed. The *cohesion* or degree of union existing among the members of the same whorl must be observed; also whether or not all the parts in any whorl resemble each other, the flower being regular or actinomorphic where they are alike, and irregular or zygomorphic if the parts are dissimilar. The placentation, or mode in which the ovules are disposed within the ovary, is another character of primary importance in identifying plants. The different whorls of a flower may be quite separate and independent of each other, or they may adhere; the degree of *adhesion* is of the greatest use in classification. This last-mentioned character is ascertained from a vertical section of the flower, and is not therefore shown in the floral diagram, since this is merely a representation of what one sees on looking down into the blossom—a ground plan in fact, into which one or two particulars from the cross section are introduced. For the present we shall confine our attention to those characters which admit of representation by means of a floral diagram, leaving aside meantime, for the sake of simplicity, adhesion and other characters which are only visible in a vertical section.



Floral diagrams, as will be readily understood, greatly assist the memory in retaining the general characters of the various natural orders, and are therefore most helpful to the beginner in botany; but besides this, they often bring out in a most instructive way the affinities of different groups. As an illustration of this we may take the Orchidaceæ, an order in which the flowers assume the most irregular, diversified, and fantastic shapes; they have little or no resemblance to the simple, regular, and symmetrical blossoms of the lily order, to which, however, they are very closely related. The Liliaceæ, which probably represent a very early monocotyledonous type, have six stamens, while *Orchis* has but one; genera allied to the latter, however, exhibit every gradation, from the hexandrous to the monandrous conditions. The single perfect stamen of orchis is homologous, with the anterior

or lower member of the outer staminal whorl of the lily; four of the others are frequently represented by protuberances or staminodes, while one is, as a rule, completely aborted. The lady's-slipper orchid, Cypripedium, has a large staminode representing the fertile stamen of orchis; its two perfect stamens correspond to the two anterior ones in the inner whorl of the lily. All three stamens of the outer whorl are present at first in the bud of *Calanthe*, but only the anterior one is ultimately developed. *Uropedium* lacks the outer whorl, but has the inner one complete, all the three stamens being perfectly developed, while five often, and occasionally the whole six members of the androecium are present in *Isochilus*.

The androecium of Iridaceæ consists of three stamens homologous with the outer whorl of the lily; the inner whorl is entirely suppressed. Although the irises are in some respects intermediate between Orchidaceæ and Liliaceæ, the fact that among the orchids sometimes the inner and sometimes the outer staminal whorl is represented shows that they cannot be directly derived from the iris type. There is apparently only one possible interpretation of such facts; they point distinctly to the six-stamened lily as the type from which both orchids and irises have diverged. This interpretation is strongly supported by anatomical considerations, the number of vascular bundles or leaf-traces present in the flower-stalk being such as we should expect in accordance with this view. These homologies, which are exhibited in the foregoing diagrams, afford as strong evidence as perhaps can be given of the origin of different species, genera and orders of plants by descent and modification from a common ancestral form.

Notwithstanding their odd and irregular shapes then, all orchids may be referred to the simple lily type. The single fertile stamen of orchis bears the same relation to the six stamens of the lily that the single enlarged toe of the horse does to the five toes of the archetype from which the horse is supposed to be descended. Cypripedium, Calanthe and to some extent the irises stand very much in the position of the eohippus and miohippus, since they represent intermediate phases in the development. In the floral series the theoretical line of descent is indicated by abortive stamens or staminodes, in the equine series by rudimentary and functionless digits.

Like the perianth of the lily, that of the orchid is composed of a sepaline and petaline whorl, each containing three leaves or segments, but while the parts of each whorl are alike in the lily, in the orchid they are dissimilar. This irregularity of the perianth arises mainly from the enlargement of the lip or labellum, which is usually prolonged into a hollow pouch or spur; it is composed of the anterior petal combined with two of the sterilized stamens. Other peculiarities of the orchid which may be mentioned in passing are the gynandrous condition caused by the adhesion of the fertile stamen to the style, the modification of one of the three typical stigmas to furnish sticky discs for the pollen masses, and the twisting of the ovary by which the labellum, which is uppermost in the bud, is brought down to the lower or anterior side of the flower.

The degraded and aberrant blossoms of grasses are connected with the lily type by a corresponding series of transitional forms. *Bambusa*, which has six stamens, differs from the type only in the absence of the outer perianth-whorl, but in most grasses the posterior leaf of the inner perianth-whorl has also disappeared, together with the whole inner whorl of stamens and the anterior carpel; the latter is the only member of the carpellary whorl present in the mat-grass, *Nardus*. The flowers of sedges are also fashioned on the lily pattern, the three inner stamens being suppressed as in iris. Zingibereæ agree with orchis in having only one fertile stamen, but its position in the ginger order is posterior, not anterior as in the orchid; the rest of the six-merous androecium is represented by petaloid pieces. The allied Canna or Indian shot has likewise all the members of the androecium developed as petals, with the exception of one which bears pollen, and is half petal, half stamen, as indicated in the diagram.

Facts of this description, and many others which might be mentioned, go to show that such regular six-merous flowers as we find in Liliaceæ, Amaryllidaceæ, Juncaceæ, and Palmaceæ, represent the primitive type from which most, if not all, existing monocotyledons have been derived. Although other divergences of character have occurred independently, which make it impossible to trace the actual descent or phylogeny of a particular species, still there is little difficulty in following the steps by which any single character has been acquired.

Equally striking are the relationships rendered apparent by the floral diagrams of dicotyledons. In the vegetable, as in the animal kingdom, the excessive repetition of similar parts is held to indicate a low grade of organization. The simplest flowers in the dicotyledonous class consist of many parts; the Nymphaceæ and Cactaceæ have numerous sepals, petals, and stamens, arranged in a spiral or acyclic manner. A corolla, consisting of twelve petals, occurs in the house-leek *Sempervivum*. The numerous stamens of the rose, buttercup, and poppy constitute a feature which these flowers have doubtless inherited from very remote and simply organized ancestors. The first two also possess numerous distinct carpels, another mark of primitive simplicity.

The great majority of dicotyledonous orders, however, admit of being referred to a floral type, consisting of six alternating whorls containing five parts each, viz., a sepaline, a petaline, two staminal, and two carpellary whorls. A close approximation to this type occurs in some of the crassulas or stonecrops. The geraniums have the formula S5, P5, St10, C5, which differs from the type only in the absence of the inner whorl of carpels. This whorl is rarely developed, possibly for want of room on the apex of the floral axis. If the number of parts in the different whorls correspond the flower is symmetrical, but the carpellary whorl is so often incomplete that it is not taken into account in reckoning symmetry. The number of carpels varies greatly even within the limits of the same order; thus among the Caryophyllaceæ it fluctuates from two to five. The presence of two carpels, on the other hand, is a constant character of the order Scrophulariaceæ, while the Leguminosæ never have more than one. The evident tendency to reduction observed in the carpellary whorls shows that there is a struggle for space among the floral organs leading to the elimination of superfluous members. Not improbably the difficulty of accommodating many members on the floral axis may originally have led to the establishment of the six whorled type as an improvement upon an earlier model made up of an indefinite number of perianth-segments, stamens and carpels. A good example of the struggle for existence among the organs of the same flower is seen in the calyx of the rock rose, *Helianthemum;* three of its sepals are much enlarged, but this has apparently taken place at the expense of the other two, which are quite rudimentary. A symmetrical decrease affecting all the whorls in the same manner is met with in the yellow tormentil; the potentillas generally have five-merous flowers, but in *P. tormentilla* the calyx and corolla have only four parts each. The same thing occurs in Rubiaceæ, Rubia having five-merous, Galium four-merous

XUM

flowers. A decrease which renders the flower unsymmetrical is of much more frequent occurrence, and, in this case, the decrease seems to be in consequence of the irregular development of the perianth tending in some way to limit the space and nutriment available for the more internal parts. The geranium, for example, has a regular five-merous calyx and corolla and ten stamens; its ally, pelargonium, which is slightly irregular and more highly specialized in relation to insects, has three of the outer stamens imperfect; Erodium, again, has regular flowers and only five stamens. The loss of symmetry in the staminal whorl is therefore closely connected with the irregularity of the floral envelopes. This connection is well exemplified in the foxglove order, which includes the mullein Verbascum, with regular five-merous flowers; also Calceolaria and Veronica, with irregular corollas and the stamens reduced to two. Most of the Scrophulariaceæ, however, are unsymmetrical and irregular, having a five-merous calyx and corolla with four stamens, but the fifth stamen is often present in a rudimentary form; thus in the figwort the nectary is a staminode, while in the garden pentstemon the fifth stamen remains as a barren stalk or filament on which no anther ever develops. As in the case of monocotyledons the most probable explanation of these various conditions is that they represent so many stages in the evolution of genera and species from a common ancestral stock. Where flowers are irregular the departure from the typical form is almost invariably in the direction of better adaptation to insects as fertilizing agents, or of specialization for the visits of particular kinds of insects; the irregularity may in part be due to the action of the insects themselves, but in any case the loss of symmetry arises from the same cause as the irregularity. There is reason to think that the cohesion of sepals or petals is also a provision in favour of insect fertilization, and it is noteworthy that this has also been generally accompanied by a reduction of stamens. In flowers like the rose with separate petals numerous stamens occur, but where the petals are united and the corolla gamopetalous seldom more than five are to be found. Irregularity is uncommon with separate petals, and where it occurs is not accompanied by loss of symmetry, as we see in the irregular but symmetrical flowers of the violet and sweet pea; it is otherwise among the gamopetalæ, where an irregular shape is much more common, and is usually accompanied by loss of symmetry. Cohesion occurs much less frequently among stamens than in the petaline whorl; it is seen, however, in the united filaments of the mallow, and in the anthers of Compositæ and Cucurbitaceæ. Cohesion is most frequent in the gynœcium, the syncarpous pistil being formed of the carpels combined into one body, very possibly as the result of compression.

Hitherto we have been occupied only with complete flowers in which four different classes of organs are present. There is a marked tendency in some families for one or more of the whorls to disappear; this is especially the case with the sepals when, as in the rhododendron, the Compositæ, and the Umbelliferæ, the flowers are produced in crowded clusters, and the protection afforded by the bracts renders sepals unnecessary. It is the corolla, however, that is much more frequently the missing whorl; the petals of many of the Ranunculaceæ are either very small or wanting, but in the anemone, globe-flower, marsh-marigold, peony, &c., this loss is compensated for by the bright colours of the sepals. The substitution of a petaloid calyx for the corolla in these instances appears to show that there is a competition between the two whorls for nourishment; it would further seem that in them the sepals have overpowered the petals, and while successful in appropriating the share of nutriment have also assumed the attractive functions pertaining to the corolla.

The dicotyledonous sub-class Incompletæ is so named on account of the absence from its flowers of one or both sets of floral envelopes. This sub-class embraces the goose-foot order, the sun-spurges, the docks, sorrels and nettles, the hop, the elm and the catkin-bearing trees, such as birch, alder, willow, poplar, oak and hazel. The bulk of these incomplete flowers are adapted for wind-fertilization. As the earlier gymnosperms had their pollen carried by the wind, it is natural to suppose that this would also be the case with the first angiosperms, but there is some doubt whether any of the original anemophilous families have survived to the present time. From the fact that the stamens in these incomplete flowers are mostly superposed to the sepals, it has been inferred that a whorl of petals must have been lost; and since petals may be supposed to have been acquired for the attraction of insects, the conclusion has been arrived at by some that all existing wind-fertilized angiosperms have degenerated from the entomophilous condition. Reversion to wind-fertilization has occurred again and again in many different entomophilous families; the common road-weed Plantago, our native Clematis and Thalictrum are without doubt examples of such reversion, but the view that all existing anemophilous angiosperms have degenerated from entomophilous ancestors, though supported by very many facts, should hardly be accepted as yet without some reservation. The mere opposition of the stamens to the sepals does not afford conclusive proof that a flower or its ancestors ever possessed petals, for, as was shown in a previous article, the superposition of whorls is a more primitive arrangement than even the alternate. The geological antiquity of several families of Incompletæ points rather to an early divergence in the direction of adaptation to wind-fertilization from a primitive unspecialized stock, which had not so far become greatly differentiated in relation to the visits of insects. It is at least a striking anomaly that those families to which the oldest monocotyledons and dicotyledons belong should be regarded as having undergone the greatest possible amount of degeneration. The aroids, which include the familiar Nile lily and cuckoo-pint, are, perhaps, the most ancient of known angiosperms, and yet they are the most degraded of all monocotyledons, so much so that the entire inflorescence is only functionally equivalent to a single flower. They are fertilized by minute flies which are temporarily imprisoned in the enlarged spathe, but it is quite a reasonable supposition that the aroids have acquired this entomophilous character without passing through any intermediate stages of high specialization either in relation to the wind or to insect agency.

THE WATER-HEN.

By Harry F. Witherby.

THE water-hen or moor-hen (*Gallinula chloropus*) is very generally distributed throughout the British Isles. It may be numbered amongst our most familiar birds, but owing to its shy nature its habits are difficult to observe.

The word "moor" seems to have once signified a marsh, and the moor-hen being an inhabitant of marshy places thus received its name, but since by "moor" we now understand heathy and more or less dry land, the name water-hen seems to be more appropriate.

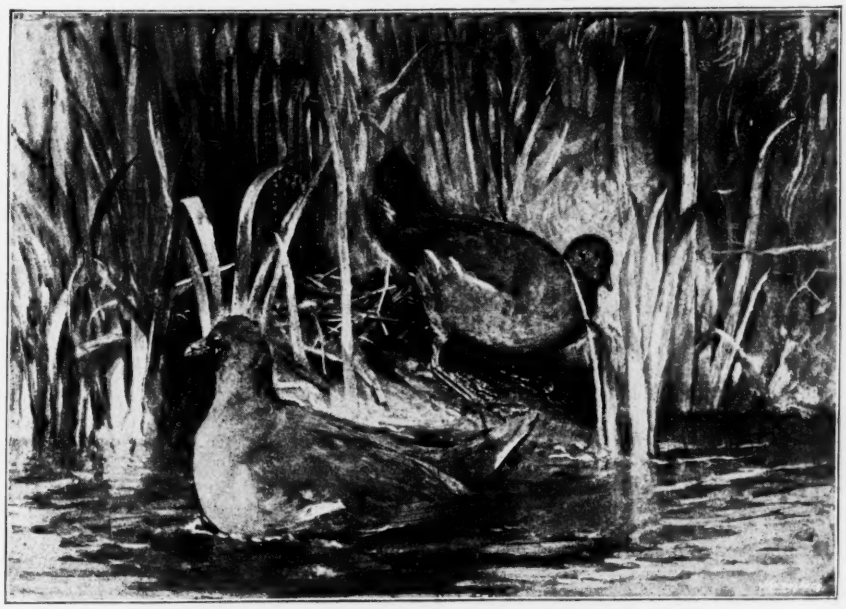
On almost every lake, pond, or stream on the sides of which reeds and rushes grow, there will be found one or more pairs of water-hen, and when frost drives them from the lakes and ponds they resort to running streams and

tidal rivers; but except on these occasions they remain, summer and winter, in the same locality.

The water-hen belongs to the rail family (*Rallidæ*), the members of which have not webbed feet, though several of them have either partially webbed feet, or are provided with an analogous growth to aid them in swimming. The water-hen has on both sides of each of its toes a narrow membrane, which expands as the foot strikes the water, thus greatly enlarging the width of the toes, and affording the foot a greater resistance against the water.

The feet are exceedingly large, and the toes very long for the size of the bird, making it look almost awkward. The usefulness of these overgrown toes, however, is soon apparent when we watch the bird gliding over reeds and rushes, and threading its way in and out through a labyrinth of flags. The bird walks with perfect ease over huge networks of reeds, which have laced themselves together after the growth of years, its large feet preventing it from slipping through the meshes.

The water-hen resorts to all sorts of methods to elude its pursuers. Sometimes it will lie motionless, hiding itself amongst rushes and refusing to fly. I have known them to lie so close that a young retriever brought one in his mouth out of some reeds. At other times the water-hen swims along half under water, like a water-logged vessel, with just the top of its back and its head and neck showing above the surface, thus often escaping notice. In swimming and diving the water-hen is also an expert; it dives down, swims some distance under the water, using both wings and legs, and suddenly comes up again at the most unexpected spots. Sometimes it will only put its head and beak above the surface, and after taking a breath of air disappears again, to rise in the midst of some rushes, amongst which it is soon lost to view.



Water-Hens and Nest; the female bird is leaving the eggs.

The bird swims with a very jerky motion, going from side to side in a restless way, and moving its head backwards and forwards as it proceeds, every now and then dipping its head into the water in pursuit of some small fish or insect.

A bird so clever in the water is usually clumsy on land, but not so with the water-hen. It walks about neatly, and runs very quickly, nodding its head and bobbing its tail, each time displaying its white under-feathers. Its adroitness on land enables it to obtain more varied food than if it were confined to the water only—grass, slugs, worms, insects, and grains being in this way added to its diet.

Although very shy, the water-hen soon becomes tame, and indeed semi-domesticated, on a piece of water near the haunts of men. If ducks are kept on the same pond the water-hens will come and feed with them when corn is thrown down, and they may often be found on ponds adjoining a railway, taking no notice of the passing trains.

Its flight is low and straight. When passing over the water it keeps so low that its legs, which hang down during flight, very often trail along the surface, leaving a track of bubbles.

The call note is a loud "crek-rek-rek," seldom uttered in the day, but during the evening the note may be repeatedly heard.

It builds its nest in very varied situations. Usually it is placed amongst reeds or rushes, but often in the branches of a tree overhanging the water and nearly touching it, and sometimes even in a branch ten or twelve feet up a tree. At other times it may be found on the top of a mass of *débris* on the bank of a stream. The water-hen is a careless builder and seldom attempts to conceal the nest, although it will often cover the eggs on leaving them. The nest is built of flags or rushes, and varies greatly in size. Though generally flat and long, I once found one round and deep, which, strange to say, was composed of leaves and grass. The eggs are six to eight in number, and they are dull white speckled with reddish-brown. Two or even three broods are reared in a season, so that although the water-hen may be a careless nest-builder she cannot be said to be an idle mother.

The first eggs are generally laid early in April, and in three weeks the young are hatched. When first hatched they appear as fluffy black balls of down, and immediately take to the water, swimming about and diving with perfect ease. In the evening the old bird may often be seen brooding the young in the nest, with perhaps one or more of her chicks on her back. When they are big enough to fly, however, they accompany their parents to roost in the bushes and trees near the water.

The eggs of this bird can be hatched under a hen, and when the young are so reared they become very tame, and may be kept in an aviary, or on ornamental water.

The female is slightly larger and a little brighter in colour than the male, but otherwise she resembles her mate. The upper parts of the bird are of a glossy olive-brown, so dark that at a distance the bird appears to be almost black. The under parts are dark slate-grey shading

down to a clouded white, while there are streaks of the same colour on the flanks. The under feathers of the tail are white, contrasting with the almost black upper feathers. The iris and bill are red, and the bill is rendered still more striking by a bright yellow tip. The legs, which are of a pale green, have a bright red band just above the so-called knee. It may here be said that what is generally known as the knee of a bird is in reality the tarsal or ankle joint, and not the knee at all; the knee joint being higher up and concealed by skin and feathers.

The young birds of the year are lighter in colour than the mature birds, and they have green beaks.

THE FACE OF THE SKY FOR SEPTEMBER.

By HERBERT SADLER, F.R.A.S.

THERE is but little diminution at present in the number of spots on the solar surface. There will be a total eclipse of the Sun on the 29th, which, however, will be invisible in Europe or America. Conveniently observable minima of Algol occur at 10h. 16m. P.M. on the 5th; at 7h. 5m. P.M. on the 8th; at 11h. 58m. P.M. on the 25th; and at 8h. 47m. P.M. on the 28th.

Mercury is too near the Sun to be observed this month; he is in superior conjunction on the 3rd.

Venus is a morning star, rising on the 1st at 3h. 1m. A.M., or 2h. 12m. before the Sun, with a northern declination of 16° 25′, and an apparent diameter of 10¾″, $\frac{92}{100}$ths of the disc being illuminated, and the apparent brightness of the planet being about what it was on February 8th. On the 10th she rises at 3h. 27m. A.M., or 2h. before the Sun, with a northern declination of 13° 5′, and an apparent diameter of 10½″, $\frac{93}{100}$ths of the disc being illuminated. On the 20th she rises at 3h. 57m. A.M., or 1h. 47m. before the Sun, with a northern declination of 8° 48′, and an apparent diameter of 10·4″, $\frac{95}{100}$ths of the disc being illuminated. On the 30th she rises at 4h. 29m. A.M., or 1h. 30m. before the Sun, with a northern declination of 4° 6′, and an apparent diameter of 10¼″, $\frac{96}{100}$ths of the disc being illuminated. During the month she pursues a direct path through the whole of Leo into Virgo, being just over ½° north of Regulus on the morning of the 11th.

Mars is an evening star, and is becoming very well situated for observation. He rises on the 1st at 8h. 34m. P.M., or 1h. 48m. after sunset, with a northern declination of 9° 15′, and an apparent diameter of 17·4″, the phase on the *s p* limb amounting to 1·7″. On the 8th he rises at 8h. 8m. P.M., or 1h. 39m. after the Sun, with a northern declination of 9° 37′, and an apparent diameter of 18·4″, the phase amounting to 1·5″. On the 18th he rises at 7h. 29m. P.M., or 1h. 22m. after the Sun, with a northern declination of 9° 50′, and an apparent diameter of 19·8″, the phase amounting to 1·1″ On the 30th he rises at 6h. 36m. P.M., or 55m. after the Sun, with a northern declination of 9° 37′, and an apparent diameter of 21·1″, the phase now only amounting to 0·5″. During the month he describes a short curved path to the N.E. of the 4½ magnitude star ξ^1 Ceti, on the confines of Cetus and Aries, the planet being situated between ξ^1 Ceti and ξ Arietis (5½ magnitude), and being stationary in the heavens on the 15th. On the evening of the 2nd an 8½ magnitude star will be closely *n p* the planet.

Jupiter is an evening star in the sense of rising before midnight. On the 1st he rises at 11h. 11m. P.M., with a northern declination of 23° 4′, and an apparent equatorial diameter of 36·0″, the phase on the *p* limb amounting to 0·3″. On the 7th he rises at 10h. 51m. P.M., with a northern declination of 23° 3′, and an apparent equatorial diameter of 36½″. On the 18th he rises at 10h. 14m. P.M., with a northern declination of 23° 1′, and an apparent equatorial diameter of 37¾″. On the 30th he rises at 9h. 26m. P.M., with a northern declination of 22° 59′, and an apparent equatorial diameter of 39¼″, the phase amounting to 0·4″. The following phenomena of the satellites occur while the Sun is 8° below and Jupiter 8° above the horizon:—On the 1st an occultation reappearance of the third satellite at 0h. 53m. A.M. On the 2nd an eclipse disappearance of the first satellite at 3h. 13m. 27s. A.M. On the 3rd a transit ingress of the shadow of the first satellite at 0h. 28m. A.M., a transit ingress of the satellite itself at 1h. 43m. A.M., a transit egress of its shadow at 2h. 43m. A.M., and a transit egress of the satellite at 3h. 59m. A.M. On the 4th a transit ingress of the shadow of the second satellite at 0h. 43m. A.M., an occultation reappearance of the first satellite at 1h. 10m. A.M., a transit egress of the shadow of the second satellite at 3h. 14m. A.M., and a transit ingress of the satellite itself at the same time. On the 6th an occultation reappearance of the second satellite at 0h. 42m. A.M. On the night of the 6th Jupiter will appear with apparently seven satellites in a small telescope. At midnight an 8·6 magnitude star will be nearly midway between the first and third satellites, rather nearer the third, the star *p* the planet about 3½′, 0·1′ south of the centre. Closely *f* the planet at the same hour (between the second satellite and Jupiter), about 1½′ *f* and ½′ south, will appear an 8·1 magnitude star, which will be just south of the planet's centre at a distance of rather over ¼′ from the southern limb at 4h. A.M. on the 7th. And at the same hour (midnight) on the 6th an 8·5 magnitude star will be about ½′ *f* the fourth satellite, and about 2¾′ south of it; at 4h. A.M. on the 7th this star will be 2½′ *f* Jupiter, and 2½′ south. Besides these, there will be six more stars between 8½ and 10½ magnitudes within a radius of 15′ from the planet, making, with the four satellites, thirteen objects visible in a field of 30′ diameter, with a planet in the centre, on a 2½ or 3 inch achromatic. On the 8th an occultation disappearance of the third satellite at 2h. 22m. A.M. On the 10th a transit ingress of the shadow of the first satellite at 2h. 22m. A.M., of the satellite itself at 3h. 39m. A.M.; a transit egress of the shadow at 4h. 37m. A.M. On the 11th an occultation reappearance of the first satellite at 3h. 6m. A.M., and a transit ingress of the shadow of the second satellite at 3h. 17m. A.M. On the 12th a transit egress of the first satellite at 0h. 24m. A.M. On the 13th an eclipse reappearance of the second satellite at 0h. 40m. 39s. A.M., an occultation disappearance of the second satellite at 0h. 49m. A.M., and its occultation reappearance at 3h. 23m. A.M. On the 15th an eclipse disappearance of the third satellite at 1h. 20m. 17s. A.M., and an eclipse reappearance of the satellite at 3h. 43m. 30s. A.M. On the 17th a transit ingress of the shadow of the first satellite at 4h. 16m. A.M. On the 18th an eclipse disappearance of the first satellite at 1h. 28m. 31s. A.M., and a transit egress of the third satellite at 11h. 25m. P.M. On the 19th a transit ingress of the first satellite at 0h. 4m. A.M., a transit egress of its shadow at 1h. 0m. A.M., a transit egress of the satellite at 2h. 17m. A.M., and its occultation reappearance at 11h. 29m. A.M. On the 20th an eclipse disappearance of the second satellite at 0h. 49m. 54s. A.M., of its reappearance at 3h. 17m. 17s. A.M., and its occultation disappearance at 3h. 28m. A.M. On the 22nd a transit egress of the second satellite at 0h. 23m. A.M. On the 25th an eclipse disappearance of the first satellite at 3h. 21m. 52s. A.M. On the 26th a transit ingress of the shadow of the first satellite at 0h. 38m. A.M., a transit ingress of the third

satellite at 0h. 44m. A.M., a transit ingress of the first satellite at 1h. 58m. A.M., a transit egress of its shadow at 2h. 53m. A.M., a transit egress of the third satellite at 3h. 29m. A.M., a transit egress of the first satellite at 4h. 14m. A.M. On the 27th an occultation reappearance of the first satellite at 1h. 23m. A.M., an eclipse disappearance of the second satellite at 3h. 26m. 1s. A.M. On the 29th a transit egress of the shadow of the second satellite at 0h. 14m. A.M., a transit ingress of the satellite at 0h. 22m. A.M., and its transit egress at 2h. 58m. A.M. The following are the times of superior and inferior conjunctions of the fourth satellite with the centre of the planet :—Superior, September 6th 0h. 57m. A.M. ; September 22nd, 7h. 42m. P.M. Inferior,, September 14th, 10h. 57m. A.M. Jupiter is in quadrature with the Sun on the 28th, and during the month he describes a direct path in Gemini, being about $\frac{1}{2}^\circ$ north of η Geminorum on the 1st, and about the same distance north of μ Geminorum on the 16th.

Saturn is invisible, and we defer an ephemeris of Neptune till October.

Uranus can still be seen, but must be looked for directly after sunset. He sets on the 1st at 9h. 14m. P.M., with a southern declination of 15° 7′, and an apparent diameter of 3·6″. On the 30th he sets at 6h. 50m. P.M., with a southern declination of 15° 32′. During the month he describes a direct path in Libra, being a little to the S.E. of a^1 a^2 Libræ at the end of the month.

There are no well marked showers of shooting stars in September.

The Moon enters her first quarter at 1h. 3m. A.M. on the 7th ; is full (harvest Moon) at 4h. 21m. A.M. on the 15th ; enters her last quarter at 0h. 32m. P.M. on the 22nd ; and is new at 5h. 44m. A.M. on the 29th. She is in apogee at 8h. A.M. on the 10th (distance from the earth 251,600 miles), and is in perigee at 6h. A.M. on the 26th (distance from the earth 227,230 miles). At 8h. 21m. P.M. on the 7th the 6th magnitude star B.A.C. 4923 will make a near approach to the lunar limb at an angle of 17°. At 9h. 3m. P.M. on the 6th the $6\frac{1}{2}$ magnitude star B.A.C. 5603 will make a near approach at an angle of 184°. At 6h. 5m. P.M. on the 9th the 6th magnitude star B.A.C. 6628 will disappear at an angle of 37°, and reappear at 7h. 4m. P.M. at an angle of 307°. At 8h. 45m. P.M. on the 11th the $5\frac{1}{2}$ magnitude star χ Capricorni will make a near approach to the lunar limb ($2\frac{1}{2}'$ distance) at an angle of 335°. At 0h. 43m. A.M. on the 12th the $5\frac{1}{2}$ magnitude star ϕ Capricorni will disappear at an angle of 72°, and reappear at 1h. 50m. A.M. (the star setting at the time) at an angle of 227°. At 1h. 17m. A.M. on the 14th the 6th magnitude star 70 Aquarii will disappear at an angle of 88°, and reappear at 2h. 16m. A.M. at an angle of 200°. At 2h. 6m. A.M. on the 17th the 4th magnitude star ε Piscium will disappear at an angle of 353°, and reappear at 2h. 43m. A.M. at an angle of 293°. At 8h. 16m. P.M. on the 18th the 6th magnitude star 27 Arietis will make a near approach at an angle of 334°. At 9h. 59m. P.M. on the 19th the $6\frac{1}{2}$ magnitude star 66 Arietis will make a near approach at an angle of 336°. At 1h. 28m. A.M. on the 20th the 6th magnitude star 9 Tauri will disappear at an angle of 84°, and reappear at 2h. 37m. A.M. at an angle of 225°. At 8h. 4m. P.M. on the same day the $5\frac{1}{2}$ magnitude star χ Tauri will disappear at an angle of 52°, and reappear at 8h. 49m. P.M. at an angle of 276°. At 0h. 48m. A.M. on the 22nd the $6\frac{1}{2}$ magnitude star B.A.C. 1746 will make a near approach at an angle of 168°, and at 11h. 10m. P.M. the $5\frac{1}{2}$ magnitude star 49 Aurigæ will make a near approach at an angle of 356°. At 0h. 41m. A.M. on the 24th the 6th magnitude star c Geminorum will disappear at an angle of 81°, and reappear at 1h. 34m. A.M. at an angle of 287°. There will be a partial eclipse of the Moon on the morning of the 15th, which will be partly visible at Greenwich. The first contact with the penumbra takes place at 2h. 0m. A.M., with the shadow at 3h. 36m. A.M. (exactly at the northernmost portion of the limb for direct image), the middle of the eclipse at 4h. 32m. A.M.—magnitude (Moon's diameter = 1) 0·225; last contact with shadow 5h. 27m. A.M. (angle 58° from north point towards the west). The Moon sets at Greenwich eleven minutes later, the Sun rising at about the same time.

Erratum.—"Face of the Sky for August," page 191, column 1, line 9, *for* "11h. 52m.," *read* "IIh. 52m."

Chess Column.

By C. D. Locock, B.A.Oxon.

COMMUNICATIONS for this column should be addressed to C. D. LOCOCK, Burwash, Sussex, and posted on or before the 12th of each month.

J. E. Gore.—It seems to us that economy of force has not been sufficiently studied in the two-movers enclosed. Some of the pieces, too, appear to be unnecessary.

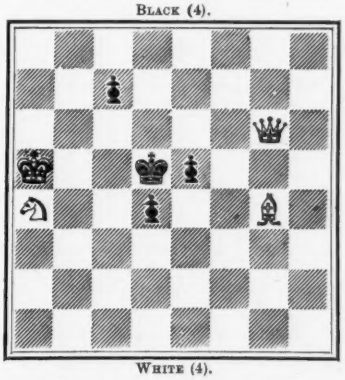
Mrs. Baird and *Messrs. B. G. Laws* and *W. De Morgan* are thanked for problems, which are marked for insertion at an early date.

W. Pennett.—Thanks for the game, which is inserted below.

PROBLEMS.

By F. H. GUEST (Smethwick).

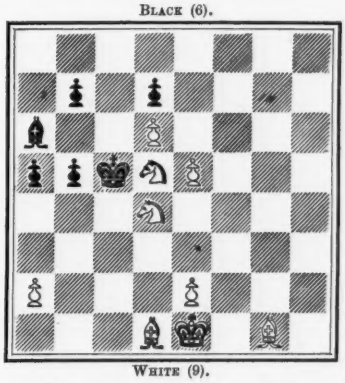
BLACK (4).



WHITE (4).

White mates in two moves.

BLACK (6).



WHITE (9).

White mates in three moves.

The following is one of nineteen simultaneous games recently played by Mr. C. Moriau at the Chess Bohemians Club:—

"EVANS GAMBIT."

WHITE (C. Moriau).	BLACK (W. Pennett).
1. P to K4	1. P to K4
2. Kt to KB3	2. Kt to QB3
3. B to B4	3. B to B4
4. P to QKt4	4. B×P
5. P to QB3	5. B to B4
6. Castles	6. P to Q3
7. P to Q4	7. P×P
8. P×P	8. B to Kt3
9. P to Q5	9. Kt to R4
10. B to Kt2	10. Kt to K2
11. B×KtP (*a*)	11. KR to Ktsq
12. B to KB6 (*b*)	12. Kt×B
13. Q to R4ch	13. Q to Q2
14. Q×Kt	14. R×KtPch
15. K to Rsq (*c*)	15. Q to R6
16. QKt to Q2 (*d*)	16. B to Kt5
17. Q to K2 (*e*)	17. Kt to Kt3 (*f*)
18. QR to QKtsq (*g*)	18. Kt to B5
19. R to Ktsq (*h*)	19. R×Rch
20. R×R	20. Kt×Q
21. Kt to Kt5	21. Kt×R
22. Kt×Q	22. Kt×Kt and wins.

NOTES.

(*a*) 11. B to Q3 is the accepted continuation here. It is less probable that Mr. Moriau was ignorant of the dangers attending this capture than that he fancied or hoped that his opponent might be in that blissful state.

(*b*) The books give 12. B to Q4, with a similar continuation, the Black Knight ultimately going to KR5.

(*c*) Clearly 15. K×R, Q to Kt5ch leads to a speedy mate.

(*d*) Or 16. B×Kt, B to Kt5; better than 16. . . Q×Kt, 17. Q to B3.

(*e*) A grave mistake. 17. Q to R4ch was much better.

(*f*) For now Black might have won the Queen at once by 17. . . R×RPch.

(*g*) As the previous note still applies, the only chance now was 18. Q to Kt5ch, K to Bsq; 19. Q to Kt3.

(*h*) Now there is nothing left; for if 19. Q to Kt5ch, P to B3, followed by R×Pch. White's defence throughout was too difficult for the simultaneous player, to whom an attacking game is always more suitable.

We have received for review a copy of the Games of the Steinitz-Lasker Championship Match, edited by Mr. J. G. Cunningham. The book, which may be obtained from 19, Bagby Street, Leeds, for 1s. 6d., is a paper pamphlet of 80 pages, resembling, externally, a double number of the British Chess Magazine. The contents consist of the biographies and performances of the two players, short accounts of their predecessors, a description of the match, and the nineteen games played in it, with copious notes quoted from various authoritative sources. The same move is frequently annotated by two or more able analysts, the result being at times strangely contradictory. The misprints of daily journalism, such as "constellation" for "continuation," are inserted without correction. But these do not in any way detract from the value of the book as a permanent record of the most important match played in this generation.

CHESS INTELLIGENCE.

Messrs. Blackburne, Mason, and Teichmann are spoken of as probable competitors in the International Tournament at Leipsic. Messrs. Loman, Trenchard, and E. O. Jones are likely to take part in the minor tournament.

A match will shortly take place at the Manhattan Chess Club between Herr Albin, formerly of Vienna, and N. Jasnagrodsky, well known in England a few years ago. Both players seem to have made the United States their permanent abode.

The correspondence games between Mr. Steinitz and the Liverpool Chess Club have been resumed. A correspondence match is also in progress between Paris and St. Petersburg. M. Rosenthal is a notable absentee from the Parisian Committee.

A match has just been concluded at Nuremburg between Dr. Tarrasch, of that city, and Herr C. A. Walbrodt, of Berlin. The result was a most decisive victory for Dr. Tarrasch by seven games to none, with only one game drawn. This is certainly a most disappointing performance on the part of the man who did not lose a single game in the Dresden International Tourney, and was thought to have improved since then. Certainly his supporters must have been surprised at his inability to draw more than a single game against his opponent, though the latter played in fine style throughout. A notable feature of the match was the absence of any time limit.

CONTENTS OF No. 106.

	PAGE
The Ancient Mammals of Britain.—1. By R. Lydekker, B.A.Cantab., F.R.S.	169
The Ptomaines formed during Putrefaction. By C. A. Mitchell, B.A.Oxon.	172
A Prolonged Sunspot Minimum. By E. Walter Maunder	173
Insect Secretions.—IV. By E. A. Butler, B.A., B.Sc.	176
On the Distribution of Stars in the Milky Way. By W. H. Wesley	179
Cloudscapes photographed at the Sydney Observatory. By H. C. Russell, F.R.S.	182
Notices of Books	183
Science Notes	184
The Rainfall of 1893. By Frederick J. Brodie	184
Some Peculiarities of Water. By J. J. Stewart, B.A.Cantab., B.Sc.Lond.	186
The Origin of the Gold of Quartz Veins. By Prof. J. Logan Lobley, F.G.S., &c.	188
The Face of the Sky for August. By Herbert Sadler, F.R.A.S.	190
Chess Column. By C. D. Locock, B.A.Oxon.	191

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Communications for the Editor and Books for Review should be addressed Editor, "KNOWLEDGE" Office, 326, High Holborn, London, W.C.